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# USSR Report

SPACE

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30 September 1985

## USSR REPORT

## SPACE

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MANNED MISSION HIGHLIGHTS

COSMONAUTS CORRECT 'SOYUZ T-13' ORBIT

Moscow IZVESTIYA in Russian 8 Jun 85 p 1

[TASS Report]

[Text] Flight Control Center. The working day of Vladimir Dzhanibekov and Viktor Savinykh on board the spaceship "Soyuz T-13" began today at 0800 Moscow time.

After checking the ship's systems and eating breakfast, the crew resumed carrying out the mission program. A series of experiments on working out various modes of control of spacecraft was performed and two corrections of the ship's trajectory were executed during the day.

According to results of medical monitoring and reports from orbit, the health of Vladimir Dzhanibekov and Viktor Savinykh is good, and they are feeling well.

The "Soyuz T-13" ship's systems are functioning normally.

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COSMONAUTS INSPECT 'SALYUT-7' BEFORE DOCKING

Moscow IZVESTIYA in Russian 10 Jun 85 pp 1, 3

[Article by A. Ivakhnov, correspondent]

[Abstract] The article provides a narrative account of the docking of the "Soyuz T-13" spaceship with the "Salyut-7" orbiting station, as recorded at the Flight Control Center. Excerpts of communications between the crew and the mission's deputy director, V. Blagov, are recorded.

It is noted that the spaceship's orbit-correction engine was fired two and one hours before the scheduled docking time. During the rendezvousing, the ship's rate of approach to the station when they were seven kilometers apart was 12 meters per second. It was subsequently reduced to six meters per second. When the two spacecraft were flying over the Crimea, the cosmonauts focused a television camera on the orbiting station. Flying around the station, they provided good pictures of its solar panels, egress hatch and docking mechanism to the Flight Control Center. They maneuvered the ship into position for the docking.

It is mentioned that the locations of ships tracking the spacecraft were in the Atlantic on the equator and off the coast of West Africa, and also in the Mediterranean Sea and the Pacific Ocean. One of the ships was the "Kosmonavt Viktor Patsayev".

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MANNED MISSION HIGHLIGHTS

TASS REPORTS DOCKING OF 'SOYUZ T-13' WITH 'SALYUT-7'

Moscow IZVESTIYA in Russian 10 Jun 85 p 1

[TASS Report]

[Text] Today, 8 June 1985, the spaceship "Soyuz T-13" docked with the orbiting station "Salyut-7". After checking the seal of the docking mechanism, cosmonauts Vladimir Dzhanibekov and Viktor Savinykh went inside the station.

In the course of the two-day independent flight of the "Soyuz T-13" ship, several corrections of the trajectory of movement were executed, as a result of which the ship came to within the prescribed distance from the station. The further rendezvousing was accomplished manually by the crew, using ranging apparatus and the onboard computer complex.

During the approach to the station, the cosmonauts inspected antennas, solar panels and other external elements of the structure. During the rendezvousing stage, they performed necessary maneuvers, and then accomplished the docking. The crew's precise actions ensured that the rendezvousing, approach and docking were accomplished precisely at the calculated time.

In line with the mission program, the crew is carrying out checks of the condition of the station's onboard systems and equipment.

Comrades Dzhanibekov and Savinykh are feeling well.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

**COSMONAUTS CHECK OUT 'SALYUT-7' SYSTEMS**

Moscow PRAVDA in Russian 11 Jun 85 p 1

[TASS Report]

[Text] Flight Control Center. The third working day on board the orbiting complex "Salyut-7"--"Soyuz T-13" began at 0900 Moscow time.

In line with the mission program, Vladimir Dzhanibekov and Viktor Savinykh are continuing to check out the condition of onboard systems and equipment of the "Salyut-7" station, which has been in low Earth orbit for more than three years.

According to trajectory measurements, the orbit parameters of the manned complex are: maximum distance from the surface of the Earth --375 kilometers; minimum distance from the surface of the Earth -- 356 kilometers; period of revolution -- 91.6 minutes; inclination -- 51.6 degrees.

Vladimir Dzhanibekov and Viktor Savinykh are feeling well. The process of adaptation to zero gravity is proceeding normally for both cosmonauts.

The flight of the orbiting complex "Salyut-7" -- "Soyuz T-13" is continuing.

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MANNED MISSION HIGHLIGHTS

'SOYUZ T-13' CREW CONTINUES REACTIVATION OF 'SALYUT-7' SYSTEMS

Moscow IZVESTIYA in Russian 13 Jun 85 p 1

[TASS Report]

[Text] Flight Control Center. Vladimir Dzhanibekov and Viktor Savinykh are continuing to carry out planned measures for the reactivation of onboard systems and equipment of the "Salyut-7" station.

Yesterday the cosmonauts did a large amount of work with the station's power supply system. They continued charging onboard batteries, checked the operation of means of control of the solar battery panels, and made measurements of electrical characteristics.

Reactivation of the lift-support system has begun. Regenerators, harmful-impurity absorbers, gas analyzers and a food warmer were connected to the power system.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

COSMONAUTS COMPLETE FIRST WEEK IN SPACE

Moscow IZVESTIYA in Russian 15 Jun 85 p 1

[TASS Report]

[Text] Flight Control Center. The first week of the work of the crew of the manned orbiting complex "Salyut-7"--"Soyuz T-13" is drawing to an end.

In line with the mission program, Vladimir Dzhanibekov and Viktor Savinykh are continuing work on reactivation of the station.

In the last two days, the cosmonauts performed check-and-preventive measures on the heat-regulating system, checked the radio and television communication equipment, and adjusted the teletype apparatus.

Today the crew is checking the functioning of the station's control system in the manual-orientation mode, and is monitoring the work of the automatic system.

According to specialists of the medical-monitoring group, the process of adaptation to zero gravity has been completed for Vladimir Dzhanibekov and Viktor Savinykh. During communications the cosmonauts report that they have gone into a normal work rhythm and are feeling well.

The flight of the orbiting complex "Salyut-7"--"Soyuz T-13" is continuing.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

COSMONAUTS COMPLETING CHECKOUT OF 'SALYUT-7'

Moscow IZVESTIYA in Russian 18 Jun 85 p 1

[TASS Report]

[Text] Flight Control Center. Vladimir Dzhanibekov and Viktor Savinykh are carrying out final operations for the reactivation of the "Salyut-7" station, in line with the mission program.

The cosmonauts have checked the functioning of the system for orientation and control of the orbiting complex in various modes of flight. They have inspected windows, and have replaced a number of units which have become depleted. They have made an analysis of the gas composition of the air in the living compartments.

Following the previous hard days of work, the crew was given time for relaxation on Saturday and Sunday. The cosmonauts cleaned up rooms of the station, exercised, and made observations of the Earth's surface

Today the crew is checking radio communications equipment and the water regenerating system, and is working on mission documents.

According to reports from orbit and results of telemetry measurements, the flight is proceeding normally.

The health of Vladimir Dzhanibekov and Viktor Savinykh is good, and they are feeling well.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

TASS REPORTS REACTIVATION OF 'SALYUT-7' COMPLETED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Jun 85 p 1

[TASS Report]

[Text] Flight Control Center. Vladimir Dzhanibekov and Viktor Savinykh have been in orbital flight for two weeks.

In line with the planned program of work, the cosmonauts have completed the reactivation of the "Salyut-7" station and the checking of the condition of onboard systems, and they have completed the necessary preventive maintenance measures. They have begun preparing scientific apparatus for planned research.

Today the crew is inventorying equipment, foodstuffs and other consumable materials on the station. In line with the medical program, the cosmonauts measured their body weight with a special instrument -- a mass meter. The day's schedule also includes physical exercise and a televised report.

According to the crew's reports and telemetry, the flight of the orbiting complex "Salyut-7"--"Soyuz T-13" is proceeding normally.

The health of V. Dzhanibekov and V. Savinykh is good, and they are feeling well.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

TASS REPORTS LAUNCH OF 'PROGRESS-24' CARGO SHIP

Moscow IZVESTIYA in Russian 22 Jun 85 p 3

[TASS Report]

[Text] In line with the program for ensuring the further functioning of the orbiting scientific station "Salyut-7", the automatic spaceship "Progress-24" was launched from the Soviet Union on 21 June 1985, at 0440 hours Moscow time.

The purpose of the ship's launching is to deliver various cargo items to the orbiting station, including equipment for the crew's life support and for conducting scientific research, as well as fuel for the station's engine assembly and equipment for conducting periodic preventive work on board the station. The overall mass of the cargo that is being delivered is 2,000 kilograms.

Plans call for docking the ship with the manned complex "Salyut-7"--"Soyuz T-13" on 23 June.

The "Progress-24" spaceship was placed into an orbit with the parameters: maximum distance from the Earth's surface--270 kilometers; minimum distance from the Earth's surface -- 193 kilometers; period of revolution -- 88.8 minutes; inclination -- 51.6 degrees.

According to telemetry data, the onboard systems of the automatic cargo spaceship are functioning normally.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

'PROGRESS-24' DOCKS WITH 'SALYUT-7'

Moscow IZVESTIYA in Russian 24 Jun 85 p 1

[TASS Report]

[Text] The automatic docking of the cargo spaceship "Progress-24" with the manned orbiting complex "Salyut-7"--"Soyuz T-13" was accomplished on 23 June 1985, at 0654 hours Moscow time.

The mutual search, rendezvousing, approach and docking of the space-craft were executed using onboard automation. These procedures were monitored by the Flight Control Center and by the crew of the orbiting complex, cosmonauts Dzhanibekov and Savinykh. The cargo ship was docked to the station on the side of its equipment compartment.

The "Progress-24" spaceship delivered into orbit fuel for the station's combined engine assembly, equipment, apparatus, materials for conducting scientific research, equipment for the crew's life support, and mail.

According to the crew's reports and telemetry data, the onboard systems of the orbiting complex "Salyut-7"--"Soyuz T-13"--"Progress-24" are functioning normally.

Cosmonauts Dzhanibekov and Savinykh are feeling well.

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MANNED MISSION HIGHLIGHTS

COSMONAUTS PARTICIPATE IN 'KURSK-85' EXPERIMENT

Moscow KRASNAYA ZVEZDA in Russian 25 Jun 85 p 1

[TASS Report]

[Text] Flight Control Center. Vladimir Dzhanibekov and Viktor Savinykh are continuing planned work on board the scientific research complex "Salyut-7"--"Soyuz T-13"--"Progress-24".

From 19 to 23 June 1985, they took part in the first stage of a comprehensive experiment, "Kursk-85", which is being conducted in line with the "Intercosmos" program of international cooperation in the field of the study and use of outer space for peaceful purposes.

Specialists of the People's Republic of Bulgaria, the Hungarian People's Republic, the Socialist Republic of Vietnam, the German Democratic Republic, the Polish People's Republic, the Soviet Union and the Czechoslovak Socialist Republic took part in this experiment, which is being performed within the framework of the program of the international space project "Study of Geosystems' Dynamics by Remote Methods".

The experiment "Kursk-85" is being conducted for the purpose of studying the condition of agricultural crops and developing methods for forecasting their harvest yields, with the aid of aerospace equipment.

Photography of the Earth's surface from the "Salyut-7" station was accompanied by photographing from artificial Earth satellites. Photographic-laboratory airplanes, helicopters and ground observation posts with the aid of new apparatus that has been developed and produced in countries that are taking part in the "Intercosmos" program.

Results of the experiment will be used in member-countries of the Council for Mutual Economic Aid, in the development of technical equipment for remote, sensing of the Earth.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

FIRST STAGE OF 'KURSK-85' EXPERIMENT COMPLETED

Kishinev SOVETSKAYA MOLDAVIYA in Russian 26 Jun 85 p 3

[TASS Report]

[Excerpt] Kursk, 24 June--The first stage of the international aerospace experiment "Kursk-85", which is being conducted within the framework of the "Intercosmos" program, has been completed. The purpose of the experiment is the study of the dynamics of geosystems by remote methods. Photography of the territory of Kursk Oblast, which was chosen as a survey area of the USSR Academy of Sciences' Institute of Geography, was conducted from on board the "Salyut-7"--"Soyuz T-13" orbiting complex and satellites of the "Cosmos" and "Meteor" series, as well as by suborbital measuring equipment based on airplanes and helicopters, and there were simultaneous ground-based observations.

"To obtain by means of photographic and radar pictures from space the characteristics of the soil and vegetation as the main components of geosystems, to determine the condition of farm-crop plantings and their optimum ripening times, and even to predict the future crop yield -- these are the tasks of the 'Kursk-85' program," reported L. Vasiliyev, head of a laboratory of the Institute of Geography and the director of the international experiment.

"One of the experiment's important characteristics is that from all altitude levels the study of the dynamics of geosystems is being conducted with the same kinds of instruments. This is convenient for the rapid analysis and comparison of the results. Many new and diverse instruments built at scientific centers of the socialist countries are being used in the experiment. This has enabled us to begin to develop a unified system for all the participants in the 'Intercosmos' program for the evaluation of results of studies done by remote methods."

The international aerospace experiment "Kursk-85", in which scientists from Bulgaria, Hungary, Vietnam, the German Democratic Republic, Poland and Czechoslovakia are also taking part, will be completed at the end of June. However, associates of the sphere station will continue the research program, which was begun during the planting of grain crops, until harvest time.

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CSO: 1866/116

MANNED MISSION HIGHLIGHTS

COSMONAUTS COMPLETE THIRD WEEK ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 29 Jun 85 p 2

[TASS Report]

[Text] Flight Control Center, Vladimir Dzhanibekov and Viktor Savinykh have completed the third week of their mission on board the orbiting complex.

During the days just past, the cosmonauts were engaged in unloading the "Progress-24" spaceship, doing routine preventive maintenance on the "Salyut-7" station, and making visual and instrument observations of land surfaces and the waters of the world's oceans.

The crew's program of work for today includes studies of the structure of the upper layers of Earth's atmosphere, technical experiments using mass-spectrometry apparatus, tests and tuning of new instruments, and physical exercises.

Yesterday was a day of medical examinations for comrades Dzhanibekov and Savinykh. Parameters of their cardiovascular systems both at rest under the effects of physical exertion were determined with the aid of the multifunctional recording apparatuses "Aelita" and "Reograf". According to the results of this examination, the condition of both cosmonauts' health is good. The commander's pulse rate is 68 beats per minute, and the flight engineer's is 62 beats per minute. Their arterial pressures are 125 over 60 and 130 over 70 millimeters of mercury, respectively.

The onboard systems of the orbiting scientific research complex "Salyut-7"--"Sojuz T-13"--"Progress-24" are functioning normally.

The work in the near-Earth orbit is continuing.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

'KURSK-85' STUDY PART OF LONG-TERM 'INTERCOSMOS' PROGRAM

Baku BAKINSKIY RABOCHIY in Russian 30 Jun 85 p 3

[Text] The first stage of the international aerospace experiment "Kursk-85" has been completed. It was part of a large-scale program of "Intercosmos" that was started last year in our republic, with the "Gyunesh-84" experiment. In the present experiment, which was conducted on a survey area of the USSR Academy of Sciences' Institute of Geography, one of the participants, along with scientists of the USSR and other socialist countries, was Candidate of Technical Sciences E.T. Dzhafarov, director of the scientific methods center for processing aerospace information of the Azerbaijan Academy of Sciences' Research and Production Association of Space Research. He related: "Everyone I talked with noted that the results of the work in Azerbaijan helped greatly in the preparing of the present experiment."

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MANNED MISSION HIGHLIGHTS

SCIENTIFIC STUDIES, MEDICAL CHECKS ABOARD 'SALYUT-7'

Moscow IZVESTIYA in Russian 3 Jul 85 p 6

[TASS Report]

[Text] Flight Control Center, 2 July. The orbital flight of the scientific research complex "Salyut-7"--"Soyuz T-13"--"Progress-24" is continuing.

In the days just past, a series of experiments using the mass-spectrometry apparatus "Astra-1" was carried out for the evaluation of parameters of the atmosphere directly surrounding the station. Scheduled maintenance work was done on the station's temperature-regulating system. The cosmonauts replaced individual assemblies and parts whose rated service life was running out with new ones which were delivered by the cargo ship.

Today's schedule on board the complex calls for medical examinations of the crew, and preparing scientific apparatus for upcoming experiments.

An examination of the bioelectric activity of Viktor Savinykh's heart as he rests will be performed using the "Aelita" multifunctional recording apparatus. This type of examination was made on Vladimir Dzhanibekov the day before.

The purpose of another medical experiment which both cosmonauts will do today is to evaluate the effectiveness of various regimens of physical exercise using the exercise bike and running treadmill.

In the course of the day the crew will inspect and test the operation of mounted and portable photography equipment, including the MKF-6M and KATE-140 cameras.

According to medical monitoring data and results of radio conversations, the condition of the health of Vladimir Dzhanibekov and Viktor Savinykh is good, and they are feeling well.

The flight of the manned complex is proceeding normally.

PTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

COSMONAUTS CONCLUDING FIRST MONTH ABOARD 'SALYUT-7'

Moscow IZVESTIYA in Russian 6 Jul 85 p 1

[TASS Report]

[Text] Flight Control Center, 5 July. The first month of the space mission of Vladimir Dzhanibekov and Viktor Savinykh is coming to an end. In this time the crew of the orbiting complex has carried out all planned activities for putting the "Salyut-7" station into the manned flight mode; they have made detailed checks of the conditions of its systems, and have performed a number of scientific studies and experiments.

The cosmonauts are completing the unloading of the "Progress-24" transport ship. They have installed equipment that was delivered in assigned places; they have replaced three blocks of storage batteries on the station, and also individual instruments, assemblies and parts with depleted service lives. Living compartments of the complex have been pressurized with oxygen from cylinders on the cargo ship.

Today's schedule calls for maintenance work on the system for regenerating water from atmospheric moisture, medical checks that will include measuring body mass and evaluating the condition of muscles, and physical exercise on the exercise bike and the running treadmill. Preparations have begun for refueling the combined engine unit. After a check of the airtightness of the fueling lines, compressed nitrogen is being pumped from the fuel tanks.

In the course of the day the cosmonauts will continue geophysical experiments in the program for study of Earth's natural resources and environment. Visual observations and photography of regions of the Atlantic Ocean are planned.

The flight is proceeding normally. The health of Vladimir Dzhanibekov and Viktor Savinykh is good, and they are feeling well.

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CSO: 1866/116

• MANNED MISSION HIGHLIGHTS

TASS REPORTS UNLOADING OF 'PROGRESS-24' COMPLETED

Moscow GUDOK in Russian 10 Jul 85 p 1

[TASS Report]

[Text] Flight Control Center, 9 July. The mission of Vladimir Dzhanibekov and Viktor Savinykh on board the manned complex "Salyut-7" -- "Soyuz T-13"--"Progress-24" is continuing.

The mission program in the past days has included work with the cargo ship, routine maintenance of individual systems of the stations, and geophysical studies. Time also was set aside for the crew's rest.

The cosmonauts have completed the unloading of the "Progress-24" transport ship. They have placed the delivered cargo in the station, and they are moving depleted equipment into the cargo ship and placing it in space that has been vacated.

After preliminary operations involving the pumping of compressed nitrogen from fuel tanks of the "Salyut-7" station, the station's combined engine unit is being refueled.

In line with the program for study of Earth's natural resources, the crew is carrying out another series of geophysical studies today. Visual and instrument observations and photography of regions of the world's oceans are planned.

The flight of the orbiting complex is proceeding normally. Vladimir Dzhanibekov and Viktor Savinykh are in good health and are feeling well.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

COSMONAUTS COMPLETE OPERATIONS WITH 'PROGRESS-24'

Moscow GUDOK in Russian 13 Jul 85 p 1

[TASS Report]

[Text] Flight Control Center, 12 July. The Fifth week of the mission of Vladimir Dzhanibekov and Viktor Savinykh on board the orbiting scientific station "Salyut-7" is ending.

The crew has carried out all planned work with the "Progress-24" ship. Yesterday the last operations for refueling the combined engine unit and pumping water into tanks of the station were completed. The cosmonauts placed depleted equipment in the cargo compartment of the ship.

Today a comprehensive medical examination of the crew is planned. It will include measurements of body mass, evaluating the condition of muscles, and determining reactions of the cardiovascular system to simulated hydrostatic pressure. The examination of cardiac activity will be performed with the aid of the pneumatic vacuum suit "Chibis", in which blood flow to the lower part of the body takes place through the action of a drop in barometric pressure, imitating Earth's gravity. Recording of physiological parameters is accomplished in the process with the "Aelita" and "Reograf" instruments.

The day's schedule also calls for experiments to determine characteristics of the atmosphere directly surrounding the orbiting complex, and visual observations and physical exercise.

The flight is proceeding normally. Cosmonauts Vladimir Dzhanibekov and Viktor Savinykh are healthy and are feeling well.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

TASS REPORTS UNDOCKING OF 'PROGRESS-24'

MOSCOW KOMSOMOLSKAYA PRAVDA in Russian 17 Jul 85 p 1

[TASS Report]

[Text] Flight Control Center, 16 July. The flight of the automatic transport spaceship "Progress-24", which was launched into near-Earth orbit on 21 June 1985, has been completed.

The cargo ship docked with the orbiting complex "Salyut-7"--"Soyuz T-13" on 23 June. The operations planned during the joint flight were carried out completely, including the unloading of the spaceship, refueling of the station's combined engine unit, and pumping of drinking water into tanks of the station.

The "Progress-24" spaceship was separated from the station on 15 July at 1628 hours Moscow time. The ship's engine was fired at the calculated time. As a result of braking, the cargo ship went into a descending trajectory, entered the dense layers of the atmosphere, and ceased to exist.

In line with the program for studying the Earth's natural resources, Vladimir Dzhanibekov and Viktor Savinykh are performing another series of geophysical studies today. Plans call for visual and instrument observations and photography of individual regions of the territories of the Central Asian republics, the Volga Basin, the North Caucasus, and the Crimea.

According to results of medical monitoring, the condition of the cosmonauts' health is good, and they are feeling well.

The onboard systems of the scientific research complex "Salyut-7"--"Soyuz T-13" are functioning normally.

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MANNED MISSION HIGHLIGHTS

BIOLOGICAL EXPERIMENTS, RESOURCES STUDIES ON 'SALYUT-7'

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 Jul 85 p 1

[TASS Report]

[Text] Flight Control Center, 23 July. The mission of cosmonauts Vladimir Dzhanibekov and Viktor Savinykh on board the "Salyut-7" station has been in progress for 45 days.

Today's program includes biological experiments aimed at studying possibilities for cultivating higher plants in conditions of orbital flight, using instruments delivered by the satellite "Cosmos-1669".

A substantial place in the cosmonauts' work has been reserved for geophysical studies. The crew will take part in the second stage of the large-scale experiment "Kursk-85", which is being conducted in accordance with the "Intercosmos" program of international cooperation in the study and utilization of outer space for peaceful purposes. Photographing of the Earth's surface from the "Salyut-7" station will be done simultaneously with photographing from artificial Earth satellites, laboratory airplanes, helicopters and ground observation posts.

Plans call for biosphere preserves on the Soviet Union's territory, specifically the Central Black-Earth Region preserve and farmlands surrounding it, to be observed and photographed while the "Kursk-85" experiment is in progress. This research is being carried out within the framework of the UNESCO International program "Man and the Biosphere".

The condition of the health of Vladimir Dzhanibekov and Viktor Savinykh is good, and they are feeling well. The flight is proceeding normally.

PTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

COSMONAUTS CONTINUE EARTH RESOURCES STUDIES

Moscow IZVESTIYA in Russian 27 Jul 85 p 1

[TASS Report]

[Text] Flight Control Center, 26 July. Cosmonauts Vladimir Dzhanibekov and Viktor Savinykh are continuing planned work on board the orbiting scientific station "Salyut-7".

The crew has performed an extensive complex of geophysical studies in the interests of solving various economic and scientific tasks, including tasks of ecological assessment of the condition of soils and vegetation of biosphere preserves of our country.

The cosmonauts have conducted visual and instrument observations and photography of areas of the Soviet Union that have promise for finding oil and gas deposits in them, and of irrigated lands of Uzbekistan, Turkmenistan and Kherson Oblast. Photography of the Southern Urals and also of regions in the south and southeast of Kazakhstan has been done in the interests of measures for nature conservation and urban development.

Today, in line with the program of studies of the Earth's natural resources and environment, the cosmonauts are making observations and using hand-held cameras and spectrometers to photograph areas of the Pamir and Tyan Shan mountains, ring structures in the Central Kyzylkumy, and separate regions of the European part of the country.

During one of the periods of radio communication with the crew of the orbiting complex, the Flight Control Center congratulated Vladimir Dzhanibekov and Viktor Savinykh on their being named members of the Soviet delegation at the 12th World Festival of Young People and Students.

The flight is proceeding normally. Both cosmonauts are in good health and are feeling well.

FTD/SNAP  
CSO: 1866/116

MANNED MISSION HIGHLIGHTS

COSMONAUTS COMPLETE 54 DAYS IN ORBIT

Moscow IZVESTIYA in Russian 31 Jul 85 p 1

[TASS Report]

[Text] Flight Control Center, 30 July. Vladimir Dzhanibekov and Viktor Savinykh have been in orbital flight for 54 days.

In line with the designated program, today the cosmonauts are carrying out their latest series of visual and instrumental observations of the European part of the Soviet Union's territory, as well as routine operations for the care of plants that are being cultivated on board the station, and they are measuring parameters of the atmosphere in the immediate vicinity of the orbiting complex. Time is also set aside for engaging in physical exercises and looking at excerpts of telecasts from the 12th World Youth and Student Festival in Moscow.

The latest medical examination of the crew was carried out yesterday. Reactions of the cosmonauts' cardiovascular systems to measured amounts of physical exertion were determined with the aid of the exercycle and the multifunctional recording apparatuses "Aelita" and "Reograf".

According to results of the examination, the condition of Vladimir Dzhanibekov's and Viktor Savinykh's health is good. The commander's pulse rate at rest is 72 beats per minute and the flight engineer's is 70 beats per minute. Their arterial pressures are 120 over 70 and 120 over 75 millimeters of mercury, respectively.

The flight of the orbiting scientific research complex "Salyut-7"--"Soyuz T-13"--"Cosmos-1669" is proceeding normally.

PTD/SNAP  
CSO: 1866/116

SPACE SCIENCES

RESEARCH AT YAKUTSK INSTITUTE OF SPACE PHYSICS

Moscow PRAVDA in Russian 9 Jul 85 p 6

[Article by V. Yermolayev, correspondent (Yakutsk)]

[Abstract] The article reports briefly on research and facilities of the Institute of Space Physics Studies and Aeronomy of the Yakutsk affiliate of the USSR Academy of Sciences' Siberian Branch, whose scientists reportedly have made a great contribution to the advancement of cosmic-ray physics and research of near-Earth space. Directions of research are said to include studies of the solar wind, the luminescence of the night sky, and of both weak and powerful cosmic particles and wave radiations. Scientists under the direction of Professor G. Krymskiy, head of the institute's theoretical department, were awarded a prize of the Siberian branch of the academy for their work. Candidate of Physical-Mathematical Sciences Yevgeniy Berezhko, a member of the group, related that Krymskiy discovered a universal mechanism of the acceleration of particles in space.

The institute's facilities include an installation for the observation of cosmic rays and their interaction with the Earth's atmosphere, particularly air showers near the Earth's surface. This installation, which is said to be the largest of four that have been built in the world, is located on the outskirts of the village of Oktemtsy, near Yakutsk. Unlike foreign counterparts, the installation permits comprehensive studies, including measurements of flows of muons which accompany extensive air showers. The complex has 1,000 detectors, which are deployed over an area of 25 square kilometers. D. Krasil'nikov and N. Yefimov, were awarded the Lenin Prize for development of the complex.

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SPACE SCIENCES

UDC 521.2

FORMING TRANSFORMATION MATRICES FOR DIFFERENT PARAMETERS OF MOTION OF  
CELESTIAL BODIES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(Manuscript received 27 Mar 83) pp 819-827

SUKHANOV, A.A.

[Abstract] In solving many problems in space dynamics it is necessary to compute matrices for transformation of certain parameters of motion to others. These matrices are needed in evaluating the influence of small perturbations of different kinds, in studying relative motion and in determining and correcting motion. The possible number of such transformation matrices is very great and much attention has been given to derivation of formulas for computing various transformation matrices. In this article the transformation matrices are not found in explicit form but are determined using elementary matrix operations. This made it possible to derive compact expressions easily used on an electronic computer. These expressions make it possible to compute transformation matrices for rectangular phase coordinates and 216 different systems of elements formed from the 20 most frequently used orbital osculating elements (not including canonical elements). Among the special features of the proposed approach is the introduction of an intermediate system of orbital elements. The quite simple formulas derived in this article make it possible to find the values of 47,089 different transformation matrices of the desired form for the two-body problem. These matrices can be computed for orbits of any type other than linear. Tables 2; references: 10 Russian.

[61-5303]

UDC 629.7

FORMING ATTAINABILITY SETS IN CONTROL OF KINETIC MOMENT OF ROTATING ASYMMETRIC SOLID BODY (SPECIAL CASES)

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 16 Aug 83) pp 828-841

SARYCHEV, A.V.

[Abstract] This article is a continuation of an article by A.A. Agrachev and A.V. Sarychev in PROBLEMS OF CONTROL AND INFORMATION THEORY, Vol 12, No 5, p 335, 1983. In that article the following problem was solved. There is an asymmetric solid (rigid) body with different main central moments of inertial rotating about a center of mass. An axis passing through the center of mass is fixed in this body and a controlling moment is applied along this axis which is proportional to the momentary scalar control value. The problem involved clarification of the possibility of a transition during some finite unfixed time  $T$  from rotation with a stipulated instantaneous value of the vector of kinetic moment to rotation with another stipulated value of this vector. After reviewing the results in the earlier article, the author examines the special case when the axis and the initial value of the kinetic moment vector lie in a special plane containing aperiodic trajectories of Euler equations of free rotation of the body. In this case the controllable motion of the kinetic moment vector occurs in the special plane and is described by a two-dimensional nonlinear controllable system. Attainability sets for such a system are determined. The results are strikingly different from those given in the earlier article. However, a combination of the results in the two articles gives a full answer to the question of the possibilities of control of the angular velocity of rotation of an asymmetric rigid body by means of one control channel. Figures 4, tables 2; references 7: 5 Russian, 2 Western.

[61-5303]

UDC 629.195

METHOD FOR SOLVING TWO-POINT BOUNDARY VALUE PROBLEM FOR OPTIMIZATION OF FLIGHTS WITH LOW THRUST

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 28 Jan 83) pp 842-847

GLAZKOV, A.I.

[Abstract] It is usually required that the trajectory of motion of a spacecraft begin at a stipulated point in phase space and end at another fixed point in phase space. This requirement can be met in various ways. Among all the trajectories there is chosen the one which corresponds to spacecraft motion with a maximum payload with a fixed launching weight. This article deals with the dynamic part of the problem of finding such a trajectory, specifically the variational problem, involving formulation of an optimum law of change of the vector  $f(t)$  of jet acceleration ensuring a minimum of the integral functional for a stipulated dynamic maneuver. The proposed method makes it possible to find an initial approximation for an optimum jet acceleration law in computations of flights of spacecarft with a low-thrust engine in a central gravity field. The advantage of the proposed method becomes clear in the case of angular flight ranges from  $180^\circ$  to  $360^\circ$  and great eccentricities of the initial and final orbits, where the transporting trajectories method frequently diverges and the initial approximation obtained by this method is far from an optimum solution. Figures 3; references 5: 4 Russian, 1 Western.  
[61-5303]

UDC 629.197.2

CHOICE OF OPTIMUM BOUNDARY CONDITIONS IN SPEED OPTIMIZATION PROBLEM

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 20 Apr 82) pp 848-857

VOYEVODIN, S.A.

[Abstract] The synthesis of optimum control is one of the fundamental problems in control of the plane rotation of a spacecraft. In such synthesis there is an uncertainty in determining the initial or final position of a body. This leads to solution of an additional problem in optimum choice of boundary conditions. However, in some cases the assumption of plane rotation is possible only when there is a limited angular velocity. Accordingly, the author examines the problem of synthesis of control, optimum with respect to speed, when there are

restrictions on angular velocity. In such a case the motion of a body is determined by the angular coordinate satisfying the system of equations:  $J\dot{\omega} = M\omega + m$ ,  $\dot{\gamma} = \omega$ ,  $w-1 \leq \omega \leq w+1$ , where  $J$  is the main central moment of inertia of the spacecraft,  $M$  is the maximum value of the controlling moment,  $m$  is a constant perturbing moment. Using these formulas as a point of departure, it is possible to find trajectories, optimum with respect to speed, for transfer of a body from an oriented position  $(\omega_0, \gamma_0)$  to a stipulated position, determined by the angular velocity  $\omega_k$  and the angular coordinate  $\gamma_k(t) = \gamma_k + \omega_k t$  ( $\omega_k$  is the rate of change of the programmed angle  $\gamma_k(t)$ ). On this basis the author gives a synthesis of optimum control and an analytical solution is obtained. Figures 4, tables 1; references: 5 Russian.  
[61-5303]

UDC 629.78

MATHEMATICAL MODELS OF NONSTATIONARY EDDY CURRENTS AND EDDY MOVEMENTS OF FLUID IN PROBLEMS OF ORIENTATION AND STABILIZATION OF ARTIFICIAL EARTH SATELLITES AND SPACECRAFT II

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 2, Nov-Dec 84  
(manuscript received 14 Jun 83) pp 867-874

RABINOVICH, B.I. and ROGOVOY, V.M.

[Abstract] A study was made of the problem of the rigid stabilization of the angular position of a spacecraft with a liquid-fuel engine in active flight segments when within the vehicle there are dampers of liquid oscillations favoring active eddy formation. A mathematical model of a spacecraft as an object of control is presented with this factor taken into account, in particular, with respect to control of angular position. This is essentially a continuation of an earlier article by the authors (KOSMICH. ISSLED., Vol 22, No 5, p 683, 1984), devoted to a synthesis of an adequate mathematical model taking into account the kinetic energy of eddy movements and representing a generalization of the traditional model. Specifically, attention is given to nonstationary eddy movements in the tanks when there are dampers in the form of fins with sharp edges in the orbital propulsion, braking and correcting segments. There is an identity of this mathematical model and a model of nonstationary eddy currents in a conducting ferromagnetic in the case of a large Reynolds number and a large Reynolds magnetic number respectively (and simultaneously with small Strouhal numbers). It is shown that by use of the harmonic balance method it is possible to reduce the models to a form convenient for solving problems in the dynamics of a closed "control volume-regulator" system. References: 7 Russian.

[61-5303]

UDC 533.951.2

OBSERVATIONS OF FLUXES OF COLD IONS FROM PLASMAPHERE INTO IONOSPHERE  
DURING NIGHTTIME IN MIDDLE LATITUDES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 24 Aug 84) pp 884-888

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[Abstract] Measurements of velocities and intensities of fluxes of cold ions from the plasmasphere into the ionosphere are given. The data were collected using a system of two plane electrostatic analyzers with a retarding potential (plane ion traps) carried in the instrument package of the "Vertikal'-10" geophysical rocket. This rocket was launched on 25 December 1981 at 1835 UT in the Volgograd region in a nearly vertical trajectory. One analyzer was oriented upward and the other downward. In the descent segment from the peak of the trajectory at 1,508 km to 1,438 km the instrumentation registered an anisotropy of currents. The current of the analyzer oriented upward exceeded the current of the analyzer oriented downward. These nighttime measurements at L~2 evidently were the first such direct measurements in the middle latitudes. The measured fluxes exceed both the theoretical and experimental values obtained earlier. A variability of fluxes in the solar activity cycle is a possible reason for these discrepancies. Measurements by the incoherent scattering method give values which are too low due to the attenuation of fluxes of H<sup>+</sup> ions from the plasmasphere as a result of a charge exchange reaction H<sup>+</sup> + O → O<sup>+</sup> + H. The measured ion fluxes from the plasmasphere are adequate for maintaining the nighttime ionosphere. Figures 5; references 12: 1 Russian, 11 Western.

[61-5303]

UDC 551.510.535

SPECTRUM OF PHOTOELECTRONS IN EARTH'S UPPER ATMOSPHERE DURING SOLAR FLARES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 5 Oct 83) pp 889-894

AVAKYAN, S.V. and KUDRYASHEV, G.S.

[Abstract] In earlier articles (S.V. Avakyan, et. al., GEOMAGNETIZM I AERONOMIYA, Vol 17, No 1, p 84, 1977; KOSMICH. ISSLED., Vol 15, No 4, p 631, 1977) it was demonstrated that true spectra of photoelectrons with energies 200-500 eV cannot be obtained without allowance for Auger electrons and even then, under quiet conditions, the error can attain a factor of 10 or more. Auger electrons appear during photoionization of the atmosphere under the influence of X-radiation with a wavelength less than 3.1 nm. It is precisely this solar spectrum range which increases most strongly, by a factor of 10 to 100, during the time of a flare. Accordingly, the contribution of Auger processes to formation of the spectrum of ionospheric photoelectrons is especially significant during a solar flare. In this article the authors make a theoretical study of change in the energy distribution of photoelectrons during solar flares in the example of the flares of 25 February 1969 and 27 December 1968, during which the spectra of photoelectrons were measured, in the latter case supplemented by other data. This is evidently the first study of the formation of ionospheric photoelectron spectra during solar flares. The decisive role of Auger electrons to the formation of photoelectrons with an energy greater than 150-200 eV was studied for the first time. The computation model was checked on the basis of experimental data, revealing a satisfactory agreement between the results of computations and variations in the intensity of photoelectrons and emission of the upper atmosphere. The computation model is suitable for evaluating the degree of disturbance of ionospheric parameters during a flare, especially above 100 km, where the role of photoelectrons greatly increases. Figures 3, tables 2; references 19: 6 Russian, 13 Western.

[61-5303]

UDC 537.591

SOLAR FLARE X-RADIATION AND HIGH-ENERGY PARTICLES ACCORDING TO  
OBSERVATIONAL DATA FROM 'VENERA-13' AND 'VENERA-14' AUTOMATIC INTER-  
PLANETARY STATIONS

Moscow KOSMICHESKIYE ISSLEDUVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 17 Aug 84) pp 906-921

BELYAKOV, S.A., DAYBOG, Ye. I., DYACHKOV, A.P. ZENCHENKO, V.M., KURT,  
VIKTORIYA G., LOGACHEV, YU. I., RUTKOVSKIY, A.I., RYUMIN, S.P.,  
STOLPOVSKIY, V.G. YUROVITSKAYA, Ye.V., VEDRENN, G. and BARA, K.

[Abstract] The interrelationship between bursts of solar hard X-radiation quanta in the energy range  $> 0.055$  MeV and flares of solar cosmic rays was investigated. The pertinent data were collected during flights of "Venera-13" and "Venera-14" in November 1981-April 1982. Data on solar flares in  $H_{\alpha}$ , thermal X-radiation and type-III radio emission revealed that the amplitude of the intensity of flare electrons and protons correlates best with flare importance in the thermal X-radiation range. By using flare importance in the thermal X-radiation range as an independent measure of intensity of a flare in which SCR particles were generated it was possible to ascertain the dependence of flare electrons of heliolongitude. This also made it possible to draw some conclusions concerning the heliolongitude range in which coronal propagation effects can be neglected. The flux of nonrelativistic flare electrons correlates better with total energy release in a burst of hard X-radiation than with the amplitude of this burst. The distributions of solar events were studied relative to the intensities of SCR electrons, thermal and hard X-radiations. It was found that the distribution functions can be approximated by a power law in most of the range of change in amplitudes, with the distribution function amplitude being dependent not only on the particular parameter for which it was determined, but also the type of event involved in the analysis. Figures 7, tables 3; references 20: 7 Russian, 13 Western.  
[61-5303]

UDC 523.6

ROLE OF INTRINSIC ENERGY SOURCE IN PHYSICAL BEHAVIOR OF SPLIT COMETARY NUCLEUS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 15 Jun 84) pp 922-941

DAVYDOV, V.D.

[Abstract] This article is a further development of an earlier publication by the author ("Manifestations of the Structure of Cometary Nuclei in the Observable Characteristics of Comets," KOSMICH. ISSLED., Vol 21, No 5, p 765, 1983). A structural model of a split cometary nucleus is described, based on the earlier formulated hypothesis of a tidal mechanism of the origin of its structure. It is shown that considerable mechanical energy is accumulated during the orbital motion of massive blocks about the center of mass of such a split nucleus. During the rapid evolution of the split nucleus its intrinsic energy is expended on the mechanical cleaning of the ice surface and ejection of small quantities of solid cometary matter and nontidal division of the main ice mass. It is postulated that the intrinsic energy of the split cometary nucleus plays the key role in the physical behavior of very active comets. The relatively small energy of the impact mechanism is capable of maintaining an enormously high level of consumption of solar energy in the sublimation of cometary matter from a cloud of ice dust in the nuclear region. The activity of such a split nucleus gradually lessens as it is gradually transformed into a system with a collisionless structure. Several hypotheses are advanced which may explain a sudden shutdown of the impact mechanism. No claim is made that this is the definitive study of the nature of origin or mechanism of evolution of split cometary nuclei, but the author regards his ideas to be based on sounder principles than those advanced earlier in the literature.

Tables 1; references 27: 15 Russian, 12 Western.  
[61-5303]

UDC 629.197.2

APPROXIMATE SOLUTIONS OF EULER-LAMBERT EQUATION FOR CASE OF SEVERAL REVOLUTIONS ABOUT CENTRAL BODY

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 28 Sep 83) pp 942-944

LIVANOV, L.B.

[Abstract] The following problem is formulated: assume that two positions (1 and 2) of a material point in a Newtonian central field with the radius-vectors  $R_1$  and  $R_2$  (the angle  $\alpha'$  between which is known) are stipulated. Such a point can experience  $n$  revolutions between positions 1 and 2. In the synthesis of spacecraft trajectories which are optimum with respect to energy expenditures it is common to solve the Euler-Lambert equations with  $n \geq 0$ . Empirical formulas have been proposed (S.V. Petukhov, KOSMICH. ISSLED., Vol 4, No 4, p 641, 1966; Livanov, L.B., KOSMICH. ISSLED., Vol 11, No 5, p 793, 1973) for approximation of the curves of the dependence of the dimensionless energy of flight orbit on dimensionless flight duration. With this formulation and the mentioned equations taken into account, the author earlier examined cases with  $n = 1$  for Earth-Venus-Earth and Earth-Mars-Earth flights but without taking the real planetary orbits into account. This has now been done; approximate solutions of the Euler-Lambert equation have been found for solving the problem precisely, but only for variants of spacecraft trajectories of practical interest. Figures 1; references: 5 Russian.

[61-5303]

UDC 523.037:525.7

FORMATION OF HIGH-ENERGY SECONDARY ELECTRONS IN LOW-DENSITY MEDIUM AT GREAT ALTITUDES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 20 Jan 84) pp 947-949

KURNOSOVA, L.V., RAZORENOV, L.A. and FRADKIN, M.I.

[Abstract] In earlier studies the authors and others proposed a mechanism of the formation near the earth of an aureole of secondary electrons of different energies, including those of  $\sim 100$  MeV or more. Such secondary electrons can be formed as a result of  $\pi^- \rightarrow e^-$  decay of  $\pi^+$  mesons arising during interactions between primary cosmic rays and the atmosphere. The flux of secondary electrons in such cases

is determined by the thickness of the effective layer of the atmosphere in which the interaction occurs. Albedo electrons are formed at low altitudes where atmospheric density is relatively great. An equilibrium flux of secondary electrons with large pitch angles, trapped by the geomagnetic field, can be generated at great altitudes where atmospheric density is small. In this case the same flux intensity as in the case of albedo electrons is ensured by the great lifetime of the trapped electrons. The formation of an aureole from trapped electrons was observed in measurements made at altitudes 200-500 km in the equatorial region; at these altitudes albedo electrons have a zone of forbidden pitch angles in the range 75-90°. Trapped electrons observed with narrow-angle telescopes revealed that their flux and energy spectrum were the same as for albedo electrons. In order to confirm these findings the authors processed old data from the "Cosmos-225" satellite. It was confirmed that when secondary electrons are formed at great altitudes in a low-density atmosphere their flux is approximately equal to the flux of albedo electrons. This supports the model proposed originally by N.L. Grigorov in DOKL. AN SSSR: FIZIKA, Vol 234, p 810, 1977. Tables 2; references 15: 12 Russian, 3 Western. [61-5303]

UDC 539.165

#### HARD GAMMA RADIATION BACKGROUND FROM CODING COLLIMATOR OF GAMMA TELESCOPE UNDER SPACE EXPERIMENT CONDITIONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 21 May 84) pp 950-951

ALEKSANDROV, A.P., BEREZOVOY, A.N., GALPER, A.M., GRACHEV, V.M., DMITRENKO, V.V., KIRILLOV-UGRYUMOV, V.G., LEBEDEV, V.V., LYAKHOV, V.A., MOISEYEV, A.A., ULIN, S.Ye. and SHVETS, N.I.

[Abstract] A recently proposed method for improving the angular resolution of gamma telescopes in the range of gamma quanta energies greater than 50 MeV is based on an aperture coding system. However, installation of a massive coding collimator completely covering the telescope aperture results in the appearance of an additional flux of gamma quanta arising due to interaction of cosmic radiation and collimator matter. It would appear that there is a special danger from the additional flux of gamma quanta formed by the neutral components of cosmic radiation because it is impossible to discriminate it by the installation of additional scintillation counters surrounding the collimator. It was postulated that the additional flux could be estimated by knowing the spatial and energy distributions of neutrons in the spacecraft compartment where the gamma telescope was installed.

Accordingly, the "Salyut-7"- "Soyuz" orbital complex carried a small "Yelena-F" gamma telescope designed so that its accompanying scintillation counter would exclude from the subsequent analysis the gamma quanta formed in the collimator by charged particles. Experiments were made with and without a collimator for different directions of the telescope axis relative to the zenith and at different geomagnetic latitudes. The collected data reveal that even under the condition  $\theta \sim 0^\circ$ , at which most gamma observations are made, a coding collimator in the telescope aperture exerts little effect on background conditions. Tables 1; references 6: 5 Russian, 1 Western.  
[61-5303]

UDC 523.752

#### SUDDEN DISAPPEARANCE OF QUIESCENT PROMINENCES

Moscow ASTRONOMICHESKIY ZHURNAL In Russian Vol 61, No 6, Nov-Dec 84  
(Manuscript received 7 Jul 83) pp 1150-1157

APUSHKINSKIY, G.P. and TOPCHILO, N.A., Leningrad State University

[Abstract] Few studies have been made of the sudden disappearance of filaments in quiescent regions on the basis of radio observations. The cases examined are the destruction of a filament on 2 July 1976 and a prominence on 30 July 1980. The observations were made with the automated RT-22 complex of the Physics Institute at wavelengths 1.35 and 0.82 cm. The following picture was observed on 30 July. The rising prominence had the form of an arch with bases in the photosphere near the ends of the deteriorating part of the filament. The axis of the arch was turned relative to the axis of the filament. The rate of arch ascent decreased with time. The prominence was optically thick during ascent to altitudes of  $\sim 400,000$  km. A decrease in  $\tau$  occurred due to a decrease in density, whereas the temperature remained constant at  $\sim 6000$  K. Only with the attainment of approximately coronal density did an intensive heating of the prominence begin, indicating good magnetic screening from the corona in the destruction process and a very small role of thermal conductivity in prominence energetics. Heating began only 73 minutes after onset of rising. A density decrease occurred both due to expansion of the arch and as a result of outflow of plasma through the bases. On the basis of these and other observations a model of the mechanism of disappearance is formulated and it is concluded that differential rotation of the solar atmosphere is the most probable cause of instability of a quiescent prominence. Figures 5, tables 1; references 14: 7 Russian, 7 Western.  
[59-5303]

UDC 523.987.2-337

MAGNETIC FIELD DETERMINATION IN QUIESCENT SOLAR PROMINENCES FROM  
POLARIZATION CHARACTERISTICS OF RADIATED LIGHT

Moscos ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 6, Nov-Dec 84  
(manuscript received 8 Aug 83) pp 1158-1167

GORNYY, M.G., KUPRIYANOV, D.V. and MATISOV, B.G., Leningrad Polytechnic  
Institute imeni M.I. Kalinin

[Abstract] A method for approximate solution of a general system of quantum kinetic equations describing the Hanle effect, based on the property of weak anisotropy of exciting light in quiescent solar prominences, is presented. In this approach it is possible to take into account the trapping of resonant radiation, a factor neglected in earlier studies of this phenomenon. An examination of the physical processes exerting an influence on the polarization properties of radiation of a prominence is followed by derivation of a system of optical pumping equations for a case when the trapping of radiation is absent. The polarization of emission of low-lying He triplet lines in a prominence is computed as a function of magnetic field strength and direction. Then the influence of trapping of resonant radiation on the polarization of an ensemble of emitting atoms is considered. The trapping of this radiation (multiple light scattering) can result in an appreciable change in the degree of polarization. Trapping can be neglected only in a study of radiation in transitions for which the prominence is an optically thin layer of absorbing matter. Any precise allowance for trapping requires a detailed knowledge of geometry of the prominence. Computations without allowance for this factor cannot be regarded as final. Figures 3; references 19:  
9 Russian, 11 Western.

[59-5303]

UDC 523.235

SPATIAL PATTERNS OF MANIFESTATION OF SOLAR ACTIVITY IN TROPOSPHERE

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 6, Nov-Dec 84  
(manuscript received 4 Jan 84) pp 1168-1178

SMIRNOV, R.V., Applied Geophysics Institute imeni Akad. Ye. K. Fedorov

[Abstract] There are relatively limited regions which could be called solar-induced atmospheric centers of action where a solar effect on the atmosphere is manifested with the greatest probability and where the amplitude of the tropospheric reaction is higher. In these regions the spatial patterns of solar-atmospheric effects are closely related

to specific physical conditions in the atmosphere. However, the postulated manifestation of solar-atmospheric relationships in such regions might only be an artifact (the probability to appearance of vorticity in these regions is great regardless of solar activity), and this problem must be examined closely. The interaction of the earth's magnetosphere with solar plasma and the development of geomagnetic disturbances gives rise to an increase in the variability of atmospheric processes, but this can occur only in regions with a high instability of meteorological processes. The solar-induced atmospheric centers of action must be regarded primarily as regions with a high baroclinic instability where a triggering mechanism of the solar effect on the troposphere takes place. In addition to processes within the atmosphere, an appreciable contribution to the variability of meteorological fields in these regions is made by an intensification of heliogeomagnetic activity. The existence of such centers of action is revealed by and confirmed by an analysis of pressure changes in the troposphere after geomagnetic disturbances and maps of advection and velocity divergence. Planetary waves in the atmosphere develop through this mechanism and infrasonic waves can be regarded as the agent connecting the lower thermosphere and the troposphere. Figures 4; references 47: 34 Russian, 13 Western. [59-5303]

UDC 523.62

#### MECHANISM OF CORPUSCULAR-ATMOSPHERIC RELATIONSHIPS

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 6, Nov-Dec 84  
(manuscript received 17 Jul 84) pp 1179-1183

MUSTEL', E.R., Astronomical Council, USSR Academy of Sciences

[Abstract] In a pioneering study by B.I. Sazonov (TRUDY GLAVNOY GEOFIZICH. OBSERV., No 316, Gidrometizdat, 1974) he postulated that the principal energy source responsible for the generation of cyclonic activity is the downward leakage of high-energy particles from the radiation belts within magnetic anomalies, but he was unable to define the specific mechanism by which this occurs. Significant advances have been made in understanding this mechanism due to research carried out in the Brazilian magnetic anomaly by Brazilian researchers. They have clearly shown that there is a dumping of high-energy particles from the radiation belts during geomagnetic storms. The assumption can be made that the same phenomenon occurs in the northern hemisphere. Data published by Brazilian and other specialists indicate that the energy contained in such dumpings can attain  $10^{24}$  erg. It is noteworthy that all four of the main climatic lows in the northern hemisphere (North American, Icelandic, Asiatic, Aleutian) coincide with the main magnetic anomalies and the dumpings of high-energy particles play an enormous role in the regions of the magnetic

anomalies which coincide with the regions of climatic lows. The hypothesis is therefore advanced that the leakage of high-energy particles from the radiation belts is accompanied by cyclogenesis. Figures 4; references 9: 5 Russian, 4 Western.  
[59-5303]

UDC 523.32

APPROXIMATE CLUSTER ANALYSIS METHOD AND THREE-DIMENSIONAL DIAGRAM OF OPTICAL CHARACTERISTICS OF LUNAR SURFACE

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 6, Nov-Dec 84  
(manuscript received 20 Jul 83) pp 1184-1191

YEVSYUKOV, N.N., Khar'kov State University

[Abstract] This article constitutes a further development of the author's previous work (ASTRON. ZH., Vol 51, p 611, 1974, Vol 61, p 366, 1984; ASTRON. VESTNIK, Vol 12, p 18, 1978), materials from which are used in this study. On the basis of three two-dimensional diagrams and corresponding two-parameter lunar maps an attempt was made at constructing a three-dimensional diagram of optical characteristics using the following parameters: albedo  $\rho$  (0.62  $\text{A}/\text{m}$ ), color index  $C_1$  (0.62/0.38  $\text{A}/\text{m}$ ) and  $C_2$  (0.95/0.62  $\text{A}/\text{m}$ ). Construction of such a map could not be accomplished without developing a special method for multidimensional cluster analysis of characteristics. The method for approximate discrimination of multidimensional clusters is discussed in detail and an algorithm is presented for multidimensional clusterization for use of all maps which have been reduced to digital form. Since the digital processing of initial lunar images requires great time expenditures, the task was simplified by replacing counts of the number of features by measurement of the corresponding map areas. A three-dimensional diagram was constructed using a  $C_1$  map with 17 discrimination levels and a two-parameter  $\rho - C_2$  map. The product is illustrated and discussed in detail. The three-dimensional diagram of optical characteristics makes it possible to evaluate the reliability of the two-parameter maps constructed earlier and the entire system of clusters; the degree of consistency was good. The interpretation of the three-dimensional clusters will be more productive after constructing a three-parameter map but the significance of the defined clusters can be clarified only after an analysis of the corresponding lunar rocks. Figures 2; references 12: 10 Russian, 2 Western.  
[59-5303]

UDC 521.134

STRUCTURE OF COEFFICIENTS OF SERIES REPRESENTING SOLUTION OF PLANE  
CIRCULAR RESTRICTED THREE-BODY PROBLEM

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 6, Nov-Dec 84  
(manuscript received 7 Jul 83) pp 1211-1217

TIMOSHKOVA, Ye. I. and TITOV, V.B., Leningrad State University

[Abstract] This is a direct continuation of earlier articles (Ye. I. Timoshkova, ASTRON. ZHURN., Vol 56, p 164, 1979; Vol 57, p 833, 1980). The first integrals for the plane circular restricted three-body problem were determined for the first time in those studies. The integrals of motion were ascertained in the form of formal series in powers of the radial distance  $r$ . The coefficients of these series are represented by trigonometric polynomials  $W_k$  of the longitude  $\theta$  of the point whose motion is studied. The purpose of this new article is an examination of some properties of the  $W_k(\theta)$  polynomials. A program was prepared for obtaining the form of the function  $W_k(\theta)$  and  $dW_k/d\theta$  in an analytical form for any  $k$ . As an example, the authors give the several first polynomials computed using this program. The convergence of the series is discussed in detail. A formula is derived which must be satisfied by the  $r$  and  $\zeta$  parameters corresponding to collinear libration points.

References: 5 Russian.

[59-5303]

UDC 521.26.803.81

A PRIORI GUARANTEED ACCURACY EVALUATION IN DETERMINING SPACECRAFT ORBIT  
BY LEAST SQUARES METHOD

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 22 Jul 83) pp 643-650

EL'YASBERG, P. Ye.

[Abstract] In solving various problems in designing spacecraft and in flight control there is a need for a priori evaluation of the anticipated accuracy in determining their orbits. This article is limited to an examination of conceivable errors caused by trajectory measurements and errors in available a priori information on the values of the parameters of the employed mathematical model of spacecraft motion. Specifically, the problem of an a priori guaranteed evaluation of the accuracy in determining an orbit by the least squares method is analyzed (see M.L. Lidov, "A Priori Evaluation of Accuracy in Determining Parameters by the Least Squares Method," KOSMICH. ISSLED., Vol 2, No 5, 1971). It is proposed that all the initial data, that is, measurements and a priori information on the parameters of the mathematical

model, be broken down into groups between which and within which different restrictions are imposed on the correlation coefficients between errors. Then formulas are derived for computing the guaranteed value of the dispersion error in evaluating any parameter being evaluated when carrying out individual and repeated measurements (in the latter case use is made of the method proposed by G. Elfving in "Optimum Estimation Allocation in Linear Regression Theory," ANN. MATH. STATIST., Vol 23, 1952). References 6: 5 Russian, 1 Western.  
[31-5303]

UDC 629.7.4.631.82

INTEGRATION OF EQUATIONS OF MOTION FOR MATERIAL POINT IN GRAVITATIONAL FIELD OF AXIALLY SYMMETRIC PLANET

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 9 Jan 84) pp 651-662

GOLIKOV, A.R.

[Abstract] The objective of the study was the writing of an approximating expression for the gravitational potential of an axially symmetric planet allowing integration of the equations of motion of its satellite in quadratures. A method is given for finding the approximating nonharmonic potential allowing such integration. In the first stage it is necessary to define the most general form of the potential  $U$  allowing integration of the Hamilton-Jacobi equation by the separation of variables. The second stage involves discrimination of an approximating expression for  $U$  for the gravitational potential from the general form of the determined potential. Then it is possible to study qualitative forms of motion of a material point in a force field with the potential  $U$ . This requires simplification of inversion of the quadratures. The trajectories found for the formulated approximation model are used as intermediate orbits in the theory of perturbed motion of a satellite. The formulated method is checked for oblate spheroidal coordinates and the possibilities of its use for other systems of curvilinear coordinates are indicated. The method gives solutions which are a generalization of all now known potentials of models of the gravity field of a planet. It is possible to obtain potentials  $U_A$  almost without changing the quality of the approximation in comparison with known models but allowing a more convenient analytical inversion of the quadratures in general solution of the motion problem. The merits of the method include the fact that the study is carried out by classical methods using already known theorems. References 8: 6 Russian, 2 Western.  
[31-5303]

DC 629.7.4.631.82

PERIODIC REGIMES OF ROTATIONAL MOTION OF SOLID BODY ABOUT LIBRATION POINT  
 $L_4$  IN RESTRICTED ELLIPTICAL THREE-BODY PROBLEM

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 16 Feb 82) pp 663-674

BARKIN, Yu. V. and LELYAVIN, S.N.

[Abstract] It has been proposed that libration points and trajectories near these points in the earth-moon system be used in space research. Accordingly, the authors investigated periodic solutions in the problem of rotational motion of a solid body situated at the triangular libration point  $L_4$  in the restricted elliptical three-body problem. This article is a direct continuation of an earlier study (Yu. V. Barkin, KOSMICH ISSLED., Vol 17, No 3, p 333, 1979) which was devoted to investigation of rotation of a body about libration point  $L_4$  in the circular restricted three-body problem. Families of periodic solutions are found in the case of a solid body M whose ellipsoid of inertia is quite close to a sphere. After the periodic solutions are found a study is made of the necessary conditions for stability of the corresponding periodic solutions. The basis for the study is the theory of periodic Poincare solutions for Hamiltonian systems of a standard form and the equations of rotational motion in normalized canonical variables. The solutions presented correspond to periodic motions of a solid body relative to the center of mass for which after one or two orbital revolutions of the main bodies  $M_1$ ,  $M_2$  the body M experiences a whole number of revolutions relative to the center of mass. The material is organized as follows: 1) Formulation of problem. Equations of motion; 2) Periodic motions of solid body with triaxial ellipsoid of inertia. First family of periodic solutions; 3) Necessary conditions for stability of periodic solutions; 4) Second family of periodic solutions for satellite with triaxial ellipsoid of inertia; 5) Periodic motions of axially symmetric body at libration point  $L_4$ . Two families of periodic solutions; 6) Stability of periodic motions of axially symmetric body about libration point  $L_4$ . Figures 3; references: 8 Russian.

[31-5303]

UDC 629.78.4.505.82

MATHEMATICAL MODELS OF NONSTATIONARY EDDY CURRENTS AND EDDY MOTIONS  
OF FLUID IN SPACECRAFT ORIENTATION AND STABILIZATION PROBLEMS. I

Moscow KOSMICHSKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 14 Jun 83) pp 638-692

RABINOVICH, B.I. and ROGOVOY, V.M.

[Abstract] In developing systems for active orientation and stabilization of spacecraft there is an increasing need for solving essentially nonstationary problems in which the external magnetic field is regulable and is used in actuating components of the control system. In such cases the total field is highly dependent not only on the command current, but also the secondary field generated by eddy currents induced in a conducting ferromagnetic. The authors have therefore formulated an adequate mathematical model of eddy currents in a conducting ferromagnetic which is correct in the frequency band characteristic for spacecraft orientation and stabilization problems. The basis for the model is asymptotic solutions of the problem in which boundary layers of both types (temporal and spatial) are represented simultaneously. This is illustrated in the example of a model of an electromagnetic actuating element in such systems. References: 16 Russian.  
[31-5303]

UDC 629.197.2

COMPARISON OF ENERGETICS OF OPTIMUM MANEUVERS AND TWO-IMPULSE MANEUVERS  
IN SOME PROBLEMS OF MOTION FROM A POINT INTO ORBIT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 2 Aug 83) pp 693-701

SKOROKHODOV, A.P.

[Abstract] Very simple one- and two-impulse maneuvers of a spacecraft have been repeatedly described in the literature and frequently are optimum with respect to fuel expenditure. However, there are many types of spacecraft maneuvering for which multi-impulse regimes would be more advantageous, although they are technically more complex. For planning purposes it is important to know how much fuel is lost by replacing optimum multi-impulse regimes by the very simple maneuvering variants. This problem is analyzed in the example of some variants of motion of a spacecraft from a point stipulated by the radius-sector and velocity vector into a final circular orbit. Among the cases examined, for example, are the following: motion of a spacecraft into an orbit close to the earth's surface; return of a spacecraft with braking into the earth's atmosphere; transfer of a spacecraft

into a geostationary orbit. The analysis revealed that in standard situations the optimum motions of a spacecraft from a point into an orbit are either very simple one- or two-impulse maneuvers or are close to them with respect to fuel expenditures. The gain by use of multi-impulse maneuvers is less than 1% in comparison with one- and two-impulse maneuvers. Sometimes, however, as in maneuvers in emergency situations, multi-impulse schemes become more advantageous than the simplest maneuvers with respect to fuel expenditure. In such cases the gain can amount to 10-15%. Figures 5; references: 8 Russian.

[31-5303]

UDC 629.197.23.332.80

OPTIMUM CONTROL PROGRAMS IN PROBLEM OF INTERORBITAL FLIGHT WITH CONTINUOUS THRUST

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 8 Sep 82) pp 702-711

ISHKOV, S.A. and SALMIN, V.V.

[Abstract] The article outlines different programs for control of the thrust vector of a spacecraft for flights between noncoplanar circular Keplerian orbits. This is followed by an analysis of the influence of the rotational motion of a spacecraft on optimum programs for control of the thrust vector. An averaging method is used in formulating a model of spacecraft motion. An optimum control program is obtained which minimizes expenditure of fuel, taking into account restrictions governed by the dynamics of angular rotation of the spacecraft. The results of computations of the energetics of interorbital flights from a low geocentric orbit to the orbit of a stationary artificial earth satellite are presented. Several possible variants of programs are proposed. The results indicated that the use of averaged equations makes it possible to obtain relatively simple analytical solutions of the problem. An optimum program for change of thrust orientation was formulated which gives a substantial gain in characteristic velocity in comparison with other programs. Allowance for spacecraft rotational motion considerably complicates the motion model, but this is adequately taken into account in the program. Figures 5, tables 2; references: 9 Russian.

[31-5303]

UDC 551.510.536

DISTURBANCES IN STRATOSPHERE AND MESOSPHERE FROM SOURCE OF ULTRAVIOLET RADIATION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 3 Apr 84) pp 712-719

KOZLOV, S.I.

[Abstract] A study was made of disturbances in the stratosphere and mesosphere from a source of ultraviolet radiation in the range of wavelengths  $\sim 1350-4000 \text{ \AA}$ . It is postulated that such sources already have been devised or that their development is entirely realistic. Nevertheless, no experiments of this sort have been carried out in the atmosphere or ionosphere. The study was therefore of a theoretical nature. The effect of radiation with  $\lambda \approx 1350-4000 \text{ \AA}$  results in photodissociation of  $O_2$  and many atmospheric trace components. Under normal conditions air is considerably dissociated at 80-90 km and therefore the most significant effects could be expected at the lower altitudes, which are examined in this article. The investigation is limited to relatively weak disturbances when the atmosphere is not heated under the influence of radiation. Emphasis in the study is on the behavior of charged particles. A photochemical model of the processes involved is proposed. The model reveals that exposure of the atmosphere to a source of UV radiation, accompanied by the photodissociation of  $O_2$  and many small neutral components, can result in an appreciable decrease in the concentrations of negative ions and an increase in  $n_e$ . Quantitatively the effect is dependent on  $h$ , on the spectral range of  $\lambda$ , and most strongly on the type of final negative ion. Many aspects of this problem remain unclear and will only be clarified by experiments in the real atmosphere. Figures 2, tables 2; references 20: 12 Russian, 8 Western.

[31-5303]

UDC 550.385.41

COORDINATED INVESTIGATIONS OF PROCESSES IN SUBAURORAL UPPER IONOSPHERE AND THROUGH IN CONCENTRATION OF LIGHT IONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 29 Dec 83) pp 720-741

SIVTSEVA, L.D., FILIPPOV, V.M., KHALIPOV, V.L., GAL'PERIN, Yu.I., YERSHOVA, V.A., NIKOLAYENKO, L.M., PONOMAREV, Yu.N. and SINITSYN, V.M.

[Abstract] The first part of this study was published in KOSMICH. ISSLED., Vol 21, No 4, p 584, 1983. It presented new experimental data on identification of the polar boundary of the trough from satellites and surface stations and gave clarification of the principal processes

in the subauroral F-region resulting in formation of a sharp polar wall of the trough. Data were also given on measurements of convection in the trough and ionospheric manifestations of the so-called polarization jet arising in the trough near the boundary of diffuse injections at the time of substorms. This second part of the study presents materials on the following subjects: results of direct measurements of position of the plasmapause simultaneously with measurements of position of the boundary of diffuse injections and the polar wall of the trough; subtroughs in concentrations of light ions at low and middle latitudes; relative positions of main ionospheric trough, trough of light ions and plasmapause; variations in intensity of geocoronal emission  $H_{\alpha}$  in subauroral zone; working model of convection and ion concentration in nighttime subauroral zone. Part II, like Part I, therefore constitutes a critical review and integration of the Soviet and western literature on these subjects which until now has been available only in fragmentary form in a wide range of publications. Figures 10, tables 1; references 82: 33 Russian, 49 Western. [31-5303]

UDC 550.388.22.292.80

#### REGISTRY OF HEAVY IONS IN AURORAL REGION DURING MAGNETIC STORMS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 16 Nov 82) pp 742-748

GOTSELYUK, Yu. V., KUZNETSOV, S.N. and KUDELA, K.

[Abstract] A thin-walled proportional counter on the "Intercosmos-17" satellite (polar quasicircular orbit, altitude about 500 km) was used in measuring the fluxes of protons and  $\alpha$ - particles in the energy range 150-300 keV/nucleon and C, N, O nuclei with an energy  $\sim 120$  keV-2.5 MeV/nucleon. The detector registered particles reflected at satellite flight altitude. The analyzed data were collected during the period of the magnetic storms of 27-28 October and 2 December 1977. Both disturbances lasted almost 24 hours and consisted of a series of substorms during which the index of geomagnetic disturbance AE attained 1200-1400. These experimental data made it possible to examine the dynamics of particles from the daytime and nighttime sides of the earth during a substorm. These data were compared with data obtained during the "Explorer-45" and "S3-3" flights and on this basis it was possible to propose a scattering mechanism which explains the registry of heavy ions at low altitudes. The following generalizations could be made concerning the behavior of ions during these two storms. During the studied periods heavy ions were injected into the depths of the magnetosphere to  $L \sim 3.5$ . Fluxes of C, N and O nuclei appeared after the flare phase of the substorm. Under disturbed conditions  $N_C, N_O/N_{\alpha}$  increases to 0.4, whereas under quiet conditions it is  $\leq 0.1$ .

The fluxes of quasitrapped protons and  $\alpha$ -particles at an altitude of 500 km are less than the fluxes in the equatorial plane. The  $N_{\alpha}/N_p$  ratio is less in the low-latitude region ( $L < 4$ ) than in the higher latitude region ( $L > 4$ ). The behavior of fluxes of protons and  $\alpha$ -particles is identical during the main phase of the storm and is different in the recovery phase. The fluxes of  $\alpha$ -particles increase on the daytime side 150-200 minutes after onset of the disturbance, whereas the proton fluxes remain quite small (this is attributable to different leakage mechanisms). Figures 4; references 15: 2 Russian, 13 Western.

[31-5303]

UDC 550.383

#### SMALL-SCALE STRUCTURE OF INTENSIVE LONGITUDINAL CURRENTS IN HIGH LATITUDES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 24 May 83) pp 749-755

VOLOKITIN, A.S., KRASNOSEL'SKIH, V.V., MISHIN, Ye.V., TYURMINA, L.O., SHAROVA, V.A. and SHKOL'NIKOVA, S.I.

[Abstract] This an analysis of the results of measurements of small-scale structures of longitudinal currents in the high latitudes made on the "intercosmos-Bulgariya 1300" satellite which was launched in August 1981 into an almost circular polar orbit at an altitude of 850 km with an inclination of 81°. The accuracy in satellite stabilization in each of the three axes was  $80 \pm 10$ . The magnetic field measurements were made with an interval of 0.08 sec using a three-component ferrosonde magnetometer with a respons  $\sim 2$  nT. The data revealed that in the high latitudes there are disturbances of the horizontal component of the magnetic field with a duration of less than 2 minutes and an amplitude  $\approx 10^2-10^3$  nT which can be interpreted as intersections of a system of longitudinal currents. These small-scale current systems are observed during geomagnetic disturbances ( $K_p \geq 3$ ). During intensive magnetospheric disturbances small-scale filaments appear within the large-scale longitudinal currents in which current density is increased by an order of magnitude or more. The possible mechanism of formation of the observed small-scale structure is a system of standing Alfvén waves. The mechanism of formation of such a system is the stratification of magnetospheric convection proposed by Atkinson and later developed by Sato and Holzer, as well as Trakhtengerts and Fel'dshteyn, for explaining auroral arcs. The size of the structure along the geomagnetic field and the anomalous resistance value are estimated. Figures 4; references 23: 7 Russian, 16 Western.

[31-5303]

UDC 581.521

FORMATION OF PROTON RADIATION BELTS IN REGION OF ENERGIES OF SEVERAL MEV

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 7 Feb 83) pp 756-762

PANASYUK, M.I. and SOSNOVETS, E.N.

[Abstract] In an earlier article (M. I. Panasyuk, KOSMICH, ISSLED., Vol 21, No 4, 1984) a comparison was made of the energy dependence of experimentally determined maxima of the radial profiles of intensities of ions in the radiation belts near the geomagnetic equator and the conclusions drawn from the theory of radial transport of ions under the influence of fluctuations of the magnetic and electrical fields. It was determined, for example, that the geomagnetic field power spectrum can scarcely be represented by a single power law in the form  $P(\nu) \propto \nu^{-p}$  with  $p=2$  in a wide frequency range. With this taken into account, the authors compared satellite data on the spatial position of the maxima of intensity of radial profiles ( $L_{jm}$ ) of protons in the energy range  $E$  from  $\sim 500$  keV to  $\sim 100$  MeV near the geomagnetic equator with computed  $L_{jm}(E)$ . This study made clear that in computing the magnetic diffusion coefficient it is essential to take into account the existence of dominating harmonics of the spectrum of geomagnetic fluctuations. The comparison indicated a good agreement in the energy region  $\sim 10-20$  MeV ( $1 \gtrsim 1.6$ ) provided that the model power spectrum for geomagnetic field fluctuations provides not only for the main spectrum  $P(\nu) \propto \nu^{-2}$ , but also for the presence of a dominating spectral harmonic at a frequency of several MHz, resulting in an increase in  $D_{0m}$  (diffusion coefficient) for protons with energies of several MeV. Figures 2, tables 3; references 13; 2 Russian, 11 Western.

[31-5303]

UDC 537.591.4.574.83

DEPENDENCE OF LENGTH OF FREE PATH OF FLARE PARTICLES ON ENERGY

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 11 Mar 84) pp 763-773

DAYBOG, Ye.I., KURT, VIKTORIYA G. and STOLPOVSKIY, V.G.

[Abstract] Within the framework of quasilinear theory it was possible to establish a correlation between the particle diffusion coefficient  $k$  (or free path length  $\lambda = 3k/v$ ) and parameters of the frequency spectrum of fluctuations of the interplanetary magnetic field (IMF). With this taken into account, the authors studied time profiles of fluxes of protons and alpha particles in the energy range 0.1-100 Mev/nucleon

registered in solar events of 24 September, 9 October and 12 October, 22 November and 27 December 1977 by instrumentation on the "Prognoz-6" artificial earth satellite. The times of the maxima of particles of the stipulated energies and the slope of the energy spectra of particles with energies up to 5 MeV/nucleon are attributable to adiabatic slowing in interplanetary space on the assumption that the diffusion coefficient is  $k \sim E^a$ , where  $E$  is the kinetic energy,  $a \sim 0.5$ , and is not dependent on  $A/Z$ , where  $A$  is the atomic number and  $Z$  is the charge. This assumption is satisfied in a quasilinear approximation if the exponent of the power spectrum of IMF fluctuations is  $q \approx 2$ . Direct measurements of the magnetic field on the "Prognoz-6" give  $q = 1.5$ . This discrepancy can be explained by the assumption that the ordinary procedure of expansion of the magnetic field in spherical harmonics does not discriminate fluctuations scattering low-energy particles. This procedure therefore cannot be used. Figures 7, tables 1; references 23: 4 Russian, 19 Western.

[31-5303]

#### OBSERVATION OF SMALL-SCALE SOLAR WIND STRUCTURE ON FRONT OF SHARP INCREASE IN PLASMA FLOW VELOCITY

Moscow KOSMICHESKIYE ISSLEDUVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 21 Jul 83) pp 774-780

AVANOV, L.A., ZASTENKER, G.N. VAYSBERG, O.L. and YERMOLAYEV, Yu.I.

[Abstract] An investigation of the behavior of interplanetary plasma was carried out aboard the "Prognoz-8" satellite using the Czechoslovakian "MONITOR" instrument. A time resolution of  $\sim 1.40$  sec was achieved, the best on record. The satellite, launched in December 1980, was put into a high-apogee orbit of 200,000 km with a period of revolution about the earth of  $\sim 4$  days. The instrument had two identical electrostatic energy analyzers of the cylindrical type for measuring the energy spectra of the ion component in the energy range from 0.140 to 4.08 keV/charge, divided into 32 uniform logarithmically spaced steps. One was oriented on the sun, whereas the other was deflected by  $70^\circ$ . The advantage of such sensor orientation is a continuous registry of solar wind ions. The instrument also had a three-collector Faraday cylinder for measuring the total flux of solar wind ions and for determining the angles of arrival of the ion flow from the ratio of the currents registered separately by the three Faraday cylinder collectors. The detail measurement data used were for the period 1958-2130 UT on 4 January 1981, during which about 4,000 spectra were obtained. It was found that there were three different states of plasma, one characterized by a low velocity of protons, another by a velocity 50 km/sec greater, and a third was intermediate, corresponding to the appearance of narrow bands on the dynamic spectrogram and a

considerable fluctuation of parameters; transition from one state to another often was observed in a distance  $< 1,000$  km. The existence of these different flow regimes is evidently a result of a two-flow structure of the solar wind. It was found that the two flows differed not only with respect to velocity and temperature, but also direction of arrival. The flow with the higher velocity moves from a region lying appreciably below the plane of the ecliptic. The concentration of ions in the two flows differs very little. There is a region of mixing of the two flows which corresponds to the region of appearance of the narrow bands on the dynamic spectrogram or a region of transition from one flow regime to another. Figures 6; references 6: 4 Russian,

2 Western  
[31-5303]

UDC 551.510.53

ELECTRICAL AND ELECTROTHERMAL CONDUCTIVITY OF PLANETARY IONOSPHERES.  
I. REFINEMENT OF THEORY

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 10 May 82) pp 781-791

PAVLOV, A.V.

[Abstract] Planetary ionospheres constitute an example of nonequilibrium multicomponent mixtures of ionized gases. The lack of explicit expressions for the second and third approximations for the coefficients of electrical and electrothermal conductivity of electrons of a multicomponent mixture of gases until now has made it impossible to find precise values of these coefficients for planetary ionospheres. Accordingly, the author has derived a more precise theoretical expression for the conductivity tensor and has found the form of the tensor of electrothermal conductivity of the ionosphere. (In a second part of the study, to be published later, the values of these effects will be given for specific situations in planetary ionospheres.) In the first, second and third approximations in Sonin polynomials it was possible to find the form of the coefficients of diffusion, thermal diffusion, electrical and electrothermal conductivity of electrons in a magnetic field in an ionospheric multicomponent, nonequilibrium mixture of gases. In addition, the general expressions for the coefficients of electron transport are reduced to a form convenient for practical applications. The dependence of the frequencies of collisions of electrons with the main neutral components of the upper atmospheres of planets (O, H, He, H<sub>2</sub>, CO, CO<sub>2</sub>) has been determined more precisely. Equations are derived for determining the rates of ambipolar diffusion of ions in a multicomponent nonequilibrium mixture of gases without a magnetic field. The form of the factor for the thermal diffusion of electrons entering into these equations was found. Finally, asymptotic expressions are derived for the thermal

diffusion factors and corrections to the diffusion coefficients for completely ionized quasi-equilibrium gases consisting of electrons and several species of ions. Tables 1; references 18: 9 Russian, 9 Western.  
[31-5303]

UDC 521.2

UNIQUENESS CONDITIONS IN EVALUATION OF LEAST SQUARES METHOD IN NONLINEAR SPACE NAVIGATION PROBLEMS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 22 Apr 84) pp 804-807

MERSOV, G.A.

[Abstract] The least squares method is used in solving various problems in space navigation and the properties of evaluations obtained using this method have been well studied for linear models. But with respect to nonlinear problems, difficulties arise due to the multiplicity of the minima of the functional used in the least squares method. The point of the global minimum is usually recommended as such an evaluation. The conditions under which such an evaluation is sound are discussed in this article on the assumption that there is a restriction on the measurement errors. The need for taking nonlinearity into account is related to the magnitude of the measurement errors and the extent of the region of a priori values of the evaluated parameters. Since the mentioned multiplicity property exists with respect to nonlinear problems, the author has formulated a procedure whereby a uniqueness of the evaluation can be ensured. References: 10 Russian.  
[31-5303]

RADIO EMISSION OF INJECTED ELECTRON BEAM WITH RESPECT TO DIAGNOSIS OF IONOSPHERIC PLASMA

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 17 Dec 82) pp 807-809

PULINETS, S.A.

[Abstract] An earlier study (V.G. Vlasov, KOSMICH ISSLED., Vol 20, No 3, p 407, 1982) proposed a method for the diagnosis of ionospheric plasma by the registry of radio emission generated by an electron beam during its injection into the ionosphere. The results of wave measurements

made in the course of the ARAKS experiment make it possible to supplement the conclusions drawn by Vlasov. The ignition of a plasma beam discharge is accompanied by high-frequency radio emission from the neighborhood of the rocket; its frequency exceeds by many times the Langmuir frequency of the background plasma. Surface observations of this emission during the ARAKS experiment revealed that the plasma beam discharge was ignited at altitudes below 170-160 km (less than 1/3 of the active part of the entire rocket flight). For the greater part of the trajectory the radio emission of the electron beam was concentrated in a lower-frequency region, specifically near the characteristic frequencies of the background plasma. By registering these wave modes it is possible to obtain information on electron density, temperature and ion composition. The most information on electron density can be obtained from data on the plasma mode near the local Langmuir frequency of electrons  $\omega_p$ , observed both before and after ignition of the plasma beam discharge. The amplitude of emission of the plasma mode increased after ignition of the discharge. Information on the undisturbed electron density can therefore also be obtained with ignition of a plasma beam discharge. The diagnosis of ionospheric plasma is entirely feasible using injected electron beams, but only along the rocket trajectory. Such diagnosis may well be possible by reception of the radio emission on the ground. Figures 2; references 14: 3 Russian, 11 Western.  
[31-5303]

UDC 581.521

#### CHARGE COMPOSITION OF ELECTRONS IN EARTH'S RADIATION BELT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 2 Mar 83) pp 809-812

LUCHKOV, B.I.

[Abstract] A new component of trapped radiation, high-energy electrons in the range  $10^1$ - $10^3$  MeV, has recently been discovered in the inner radiation belt. Measurements made on the "Salyut-6" and the "Bolgariya-1300" artificial satellite indicate that their flux at  $L = 1.12$ - $1.5$  is  $I_e(\geq 30 \text{ MeV}) \approx 10^3$ - $10^4 \text{ m}^{-2} \cdot \text{sec}^{-1} \cdot \text{sr}^{-1}$ . Their existence had long been postulated, but their detection was difficult due to their relatively small flux and the strong background of protons and low-energy electrons. Their origin in the radiation belt is not yet known and may be related to two different processes: 1) cosmic ray albedo, 2) acceleration of electrons in the course of their drift from the outer magnetosphere to the low  $L$ -shell. These processes lead to different energy and charge compositions of the high-energy particles. This article examines the available indirect information on the charge composition of these electrons and discusses some experimental possibilities of ascertaining the sign of these charges.

The energy spectrum, spatial distribution and charge composition of radiation belt electrons can be determined by measuring their synchrotron radiation. Observations of this synchrotron radiation must be made in the interval of centimeter waves from regions adjacent to the geomagnetic equator. (The synchrotron radiation of the Jovian radiation belt has been studied in great detail and the collected data can be used in drawing conclusions concerning the charge composition of high-energy electrons in the radiation belt of that planet. The similarities of the inner magnetospheres and radiation belts of Jupiter and the Earth warrant closer study, because in this way qualitative conclusions could be drawn concerning the composition of high-energy electrons in circumterrestrial space.) References 15: 11 Russian, 4 Western.

[31-5303]

UDC 524.5

WAVE INTERPRETATION OF MEASUREMENTS ON 'MARS-7' AND 'VENERA-9' PROBES  
FOR DETERMINING VELOCITY OF MOTION OF INTERSTELLAR GAS

Moscow PIS'MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 10, No 12, Dec 84  
(manuscript received 11 May 84) pp 908-911

GRIVNEV, Ye.M., Astrophysics Institute, Tajik Academy of Sciences,  
Dushanbe

[Abstract] In the Lin theory of density waves (explaining the spiral structure of galaxies) it is necessary to determine the values of the free parameters of the theory (angular velocity of spiraling form  $\Omega_p$  and amplitude of the disturbance  $\varphi_1(R, 0)$  of the main axisymmetric galactic potential  $\varphi_0(R)$ ). Accordingly, a method is proposed for ascertaining  $\Omega_p$  and  $\varphi_1$  in our Galaxy on the basis of direct measurement data from the "Mars-7" and "Venera-9" on the velocity of motion of interstellar gas in the neighborhood of the solar system ( $R$  and  $\theta$  are galactocentric coordinates). Computations are presented which show that the random velocity of interstellar gas in the neighborhood of the solar system is less than the local speed of sound  $c = 9$  km/sec; therefore the angular velocity of the spiral structure should be in the range of values  $\Omega_p = 12-16$  km/sec.kps and the potential disturbance should be 5-10% of the main potential of the Galaxy. The error in the free parameters of the theory of density waves in the Galaxy, as determined in this article, is estimated:  $\Omega_p$  and  $\varphi_1$  are determined with an accuracy to 10-20%. References 10: 4 Russian, 6 Western.

[84-5303]

INTERPLANETARY SCIENCES

'VEGA'1' RELEASES AEROSTAT AND LANDER AT VENUS

Moscow KOMSOMOLSKAYA PRAVDA in Russian 12 Jun 85 p 1

[TASS Report]

[Text] An important stage of the international project "Venus--Halley's Comet" has been accomplished. A fundamentally new experiment for the study of the circulation of Venus' atmosphere and of its meteorological parameters was begun on 11 June 1985.

Flying a distance of approximately 500 million kilometers in six months, the "Vega-1" station reached the vicinity of Venus and on 9 June released a descent module which entered the atmosphere on 11 June. This module separated into a landing module and an aerostatic probe.

The aerostatic probe, whose gas bag filled with helium following the separation, is drifting in the atmosphere at an altitude of 54 kilometers. Installed on the probe are a radio-transmitting complex and scientific apparatus for measurements of parameters of Venus' atmosphere and cloud cover. The receiving of radio signals from the aerostatic probe and also the determining of its coordinates and rate of movements in the planet's atmosphere are being accomplished by Soviet and international networks of ground radio telescopes which are operating in line with a coordinated program on the territory of Europe, Asia, Australia, Africa, and North and South America.

During the descent of the landing module, studies of the cloud cover and of physical characteristics and the chemical composition of the atmosphere which were begun during previous missions of Soviet automatic stations were continued with the aid of the set of scientific instruments installed on it. The landing module made a soft landing at a point which has the coordinates 7 degrees 11 minutes North latitude, and 177 degrees 48 minutes longitude, in the vicinity of the Rusalki plain. A complex of scientific studies was carried out on the surface of Venus. The receiving and retransmission to Earth of scientific information from the landing module were accomplished with the aid of the radio system of the "Vega-1" station.

French specialists took part with Soviet scientists in the development of the scientific apparatus of the landing module and of the aerostatic probe.

After releasing the descent module, the "Vega-1" automatic station has proceeded to a distance of 39,000 kilometers from the surface of Venus and is continuing its flight toward Halley's Comet.

The interplanetary station "Vega-2", which was launched six days later than the "Vega-1" station, will reach the vicinity of the planet Venus on 15 June 1985.

According to telemetry data, the onboard systems of the aerostatic probe and of the automatic stations are functioning normally. Scientific information is being received and processed at the USSR Academy of Sciences' Institute of Space Research, and also at other Soviet and foreign scientific centers which are participating in the international project "Venus-Halley's Comet."

FTD/SNAP  
CSO: 1866/116

OBJECTIVES OF 'VEGA' PROJECT RESEARCH

Moscow KOMMUNIST in Russian 13 Jun 85 p 4

[Article by T. Breus, Candidate of Physical-Mathematical Sciences, head of a sector of the USSR Academy of Sciences' Institute of Space Research (Moscow)]

[Abstract] The author comments on the objectives and methods of meteorological and geochemical studies of the planet Venus that were done by probes from the automatic interplanetary stations "Vega-1" and "Vega-2".

These experiments called for using aerostatic probes for the first time to obtain information on the dynamics of Venus' atmosphere; determining the atmosphere's sulfuric acid content by direct methods for the first time; obtaining new data on the chemical composition and structure of clouds of Venus and on trace elements in the planet's atmosphere; and determining the element composition of the planet's soil in new locations, with the aid of the stations' landing modules. Each module was also equipped with apparatus for measuring, during its descent, the pressure and average temperature values of Venus' atmosphere, as well as fluctuations of these values. This apparatus went into operation immediately following the opening of the module's brake parachute.

The author notes that one of the main objectives of the cloud studies was to obtain a more precise picture of photochemical processes which are responsible for the formation of the planet's cloud layer. Although earlier measurements indicated that it consists chiefly of sulfuric acid (with a concentration of 75-85 percent) with a trace of chlorine, scientists wished to determine the form in which the chlorine is present and whether still other components are present in the layer.

The laboratory of planet atmosphere dynamics of the USSR Academy of Sciences' Institute of Space Research is credited with developing scientific instruments for meteorological measurements with the "Vega" stations' aerostatic probes. French scientists and U.S. specialists reportedly took part in these experiments. The author notes that the American representatives had to play the role of unofficial 'subcontractors' to the French, since the United States and NASA were prohibited from direct participation in the "Vega" project.

INTERPLANETARY SCIENCES

'VEGA-2' RELEASES AEROSTAT AND LANDER AT VENUS

Moscow KOMSOMOLSKAYA PRAVDA in Russian 16 Jun 85 p 1

[TASS Report]

[Excerpt] Soviet science and technology have written another bright page in the history of cosmonautics. An important stage of comprehensive scientific studies of the atmosphere and the surface of the planet Venus has been accomplished. On 15 June 1985, the automatic interplanetary station "Vega-2" released a landing module and an independent aerostatic probe into the planet's atmosphere. The station has passed beyond Venus to a distance of 24,500 kilometers from its surface and is continuing its flight toward Halley's Comet.

On 13 June a descent module separated from the station as it was approaching Venus. This module separated into an aerostatic probe and a landing module on 15 June.

The aerostatic probe descended on a parachute. After its gas bag filled with helium, the probe began drifting in the planet's atmosphere at an altitude of 54 kilometers, making regular measurements of meteorological parameters. Soviet and international networks of ground radio telescopes are receiving information from the probe, which is equipped with a unique radio system, and they are fixing its coordinates and rate of movement.

The landing module made a soft landing on the dark side of Venus at a point which has the coordinates 6 degrees 27 minutes South latitude, and 181 degrees 5 minutes longitude, in the region of the Rusalki plain.

The composition and physical characteristics of the atmosphere were studied as the module descended through it. On the planet's surface, the surface layer of the planet's ground was drilled into the samples were taken and analyzed for the purpose of determining the element composition of rocks in the new region. These operations were performed in conditions of an environment with a temperature of 452 degrees Celsius and a pressure of 86 atmospheres, with the aid of a soil-gathering device installed on the module.

Physical-mechanical properties of the surface layer of the ground were determined with the aid of an extension instrument. Data on the operation of the landing module's systems and scientific instruments were received and relayed to Earth by the automatic interplanetary station "Vega-2".

The planned program of research of Venus' atmosphere with the aid of the "Vega-1" station's aerostatic probe has been carried out in its entirety. This probe traveled a distance of about 10,000 kilometers while drifting at an altitude of about 50 kilometers and at an average speed of 200 kilometers per hour, moving from the planet's dark side to the sunlit side.

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INTERPLANETARY SCIENCES

RESULTS FROM 'VEGA' ATMOSPHERE AND SOIL STUDIES

Moscow TRUD in Russian 16 Jun 85 p 3

[Article by V. Golovachev, special correspondent at the Flight Control Center]

[Abstract] The article gives an account of activities at the Flight Control Center as data on the atmosphere and soil of the planet Venus were being received from the aerostatic probe and landing module delivered by the "Vega-2" space station.

Mention is made of some of the features of this equipment, as well as initial results of work with it. In Venus' high temperature and atmospheric pressure, the descent module reportedly functioned for a period twice as long as its rated service period. Following the landing module's touchdown in the region of the Rusalki plain, it took about 90 seconds to lower the module's soil-gathering device and begin drilling into the planet's surface. A soil sample which was taken was conveyed to a microlaboratory compartment for analysis. The pressure inside this compartment is about one-tenth of an atmosphere. It is noted that earlier studies of surface rocks on Venus showed that they are intermediate between basalts and granites with respect to content of natural radio-active elements; their features differ depending on location, however. Quick analysis of the sample taken in the Rusalki plain area indicated that it was soft soil with a compressive strength similar to that of loose andesite-basalt soils on Earth.

R.Z. Sagdeyev, director of the USSR Academy of Sciences' Institute of Space Research, and V.M. Balebanov, deputy director of this institute, are quoted regarding the progress of the international probe of Venus and Halley's Comet. Commenting on results of atmosphere observations with the aid of aerostatic probes, Sagdeyev mentioned that Probe-1, which was released from "Vega-1", began its drift over a region near Venus' equator where much volcanic activity and many lightning discharges occur. The probe drifted at a rate of approximately 200 kilometers per hour. Sagdeyev reported that concentrations of sulfuric acid in clouds of Venus were recorded by means of direct studies for the first time, and that at least five layers are distinguishable in the clouds that were studied.

INTERPLANETARY SCIENCES

PRESS CONFERENCE ON FIRST STAGE OF 'VEGA' PROJECT

Riga SOVETSKAYA LATVIYA in Russian 18 Jun 85 p 3

[Article by V. Ovcharov, correspondent]

[Excerpt] An unusual phenomenon--the rapid rotation of Venus's cloud layer around the planet--has received reliable experimental confirmation. This was reported to Soviet and foreign journalists at a press conference which was held on 15 June at the USSR Academy of Sciences' Institute of Space Research in connection with the successful completion of the first stage of the international project "Venera--kometa Galleya".

"A big event took place today," noted V. Kotelnikov, vice-president of the USSR Academy of Sciences. "The second station flew by Venus on its way to Halley's Comet. Unique scientific information has been transmitted to Earth with the aid of instruments delivered by 'Vega-1' and 'Vega-2'."

Specialists emphasized that data obtained from the aerostatic probes is of particular interest. The first of these probes, which was in flight for 46 hours and traveled more than 10,000 kilometers in the planet's atmosphere, transmitted information which indicates that the clouds carried it around Venus at a rate of 60-70 meters a second! Scientists were just as surprised by the force of ascending and descending currents, whose velocity was as high as 1 meter per second. These winds of hurricane force, by Earth's standards, literally hurled the aerostat upward and downward with a motion amplitude of 200-300 meters. Although these data are preliminary in character. They leave no doubt that the circulation of Venus' atmosphere is powerful.

"We are very encouraged by results obtained from the landing modules and the first probe," said academician R. Sagdeyev, chairman of the International Scientific and Technical Committee for the "Venera--kometa Galleya" project. "The sixth period of communications with the second probe has just taken place, and this probe continues to transmit additional information."

A group of French scientists arrived in Moscow on the eve of the landing of the descent module of "Vega-2". This group was headed by J. Ruenaveau, technical director of the project for the National Space Research Center.

"Scientists of our country took part in the preparation and carrying out of four experiments connected with the present stage of the 'Vega' program," she reported. "Moreover, the space center in Toulouse was responsible for coordinating the international network of radio telescopes that received signals from the probes."

FTD/SNAP  
CSO: 1866/116

INTERPLANETARY SCIENCES

FURTHER COMMENTS ON RESULTS OF 'VEGA' STUDIES OF VENUS

Moscow PRAVDA in Russian 1 Jul 85 p 3

[Article by A. Pokrovskiy]

**[Abstract]** The article records comments of specialists involved in the Venus probe segment of the "Vega" project, regarding results of measurements with the landers and aerostats that were dropped on the planet from the space stations on their way to a rendezvous with Halley's Comet.

Regarding the experiment which studied the circulation of Venus' atmosphere using aerostatic probes, V. Linkin, head of a laboratory of the USSR Academy of Sciences' Institute of Space Research and one of the directors of the experiment, said that the theory of super-rotation of the planet's atmosphere postulated 20 years ago was confirmed by the findings. The first aerostatic probe drifted for more than 10,000 kilometers during 46 hours. He noted that the aerostats were buffeted around as they drifted in Venus' atmosphere, being forced up or down by as much as 300 meters.

V. Moroz, head of a department of the space research institute, related that analysis of readings of aerosols and their distribution in the atmosphere has disclosed the presence of components that were not known before, and that the content of water vapor in the atmosphere on the dark side of Venus now is known. L. Mukhin, head of a laboratory of the institute, reported that for the first time the presence of sulfuric acid in Venus' clouds was confirmed by direct measurements, and that chlorine was also recorded.

Corresponding member of the USSR Academy of Sciences V. Barsukov, director of the academy's Institute of Geochemistry and Analytical Chemistry, observed that it was important that soil was analyzed in a part of the planet that had not been studied before. Previously the soil composition was known for only two points on the planet, and the readings from the new point indicate that is different.

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INTERPLANETARY SCIENCES

DEVELOPMENT OF INSTRUMENTS FOR 'VEGA' PROBES

Frunze SOVETSKAYA KIRGIZIYA in Russian 22 Jun 85 p 4

[Article by A. Barshay, correspondent]

[Abstract] The article reports on the development of unique instruments at the Frunze Special Design Bureau of the USSR Academy of Sciences' Institute of Space Research (OKB IKI). These instruments were used in studies of the planet Venus' atmosphere which were conducted with the aid of the automatic interplanetary stations "Vega-1" and "Vega-2."

One of these instruments, the PVD-AZ, was intended for controlling all operations for placing aerostatic probes into Venus' atmosphere following their separation from the stations' landing modules. Commands issued by this high-precision, preprogrammed timing device were formulated in accordance with its program and data from pressure and temperature sensors. A group of specialists headed by chief designer Nikolay Vasil'yevich Rempel is credited with the development of the PVD-AZ.

Two other instruments developed at the bureau were installed on the stations' landing modules. Aerosols in Venus' cloud cover were analyzed with the aid of the first of these instruments, the ISAV-A. It was equipped for this purpose with a highly sophisticated and precise optical system with its own light source. The second instrument, the ISAV-S, was intended for analyzing the gas composition of Venus' atmosphere by the method of active spectrophotometry. Data was gathered by these instruments during the modules' descent to the surface of Venus. All of this information was electronically processed and transmitted to a "Vega" station, which relayed it to Earth. Commenting on foreign participation in this project, Robert Mikhaylovich Yakhin, the bureau's chief designer of ISAV instruments, mentioned that a detector for the ISAV-S and electronics for this detector were developed by French specialists.

V.I. Fuks, chief engineer of IKB IKI, identified a number of bureau personnel who took part in the development of the ISAV instruments. Among them were Sultanbek Raimbekovich Tabaldyyev and Vladimir Gavrilovich Popov, deputy chief engineers for designing and production.

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CSO: 1866/116

INTERPLANETARY SCIENCES

BROCHURE ON PHOBOS AND DEIMOS

Moscow FOBOS I DEYMOS - SPUTNIKI MARSA (NOVOYE V ZHIZNI, NAUKE, TEKHNIKE: SERIYA "KOSMONAVTIKA, ASTRONOMIYA") in Russian No 1, Jan 85, pp 2-6, 53-54

[Excerpts from booklet "Phobos and Deimos, the Satellites of Mars", by Vladimir Naumovich Zharkov and Aleksandr Vasilyevich Kozenko, from series "Cosmonautics, Astronomy", Znaniye, 33,405 copies 62 pages]

[Excerpts] Annotation

The book describes the Martian satellites, the study of which has made significant progress in recent years due to the use of space vehicles. The interest in Phobos and Deimos is caused, among other things, by that they seem to belong to the class of small objects which are very common to our solar system.

The book is intended for a wide circle of readers interested in problems of modern astronomy.

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INTRODUCTION

Nine large planets revolve around the Sun. In the order of their distance from the Sun they are: Mercury (0.39 a.u.), Venus (.72), Earth (1.0), Mars (1.52), Jupiter (5.20), Saturn (9.54), Uranus (19.19), Neptune (30.07), Pluto (39.52). The distances in parentheses are given in astronomical units (1 a.u. equals 149.6 million km).

By their physical properties the planets are divided into two groups (the numbers in parentheses represent the mass and the average density of the planet): a) the Earth group: Mercury (.3302x10<sup>27</sup> g; 5.44 g/cm<sup>3</sup>), Venus (4.869x10<sup>27</sup>; 5.25), Earth 5.97x10<sup>27</sup>; 5.514), Mars (.6422x10<sup>27</sup>; 3.94); and b) the giant planets: Jupiter (1.902x10<sup>30</sup>; 1.334), Saturn (.569x10<sup>30</sup>; .69), Uranus (.0872x10<sup>30</sup>; 1.26), Neptune (.103x10<sup>30</sup>; 1.67).

The least known and the most distant of the planets, Pluto, has the mass 390 times smaller than that of Earth, and by its properties is similar to Jupiter's satellites, Ganymede and Callisto, rather than any of the planets.\*

The two groups are separated by the asteroid belt, several thousands of minute planets 1 to 1000 km in diameter which revolve around the Sun in elliptical orbits. This belt, or more precisely, the ring, of asteroids occupies the 2-4 a.u. interval of distance from the Sun. The combined mass of all asteroids is surprisingly small, only 1/20th of that of the Moon. This indicates that they are not remnants of some large planet destroyed in a catastrophe; their combined mass is too small for that. At present, it is considered certain that the last planet was prevented from forming in the Earth group by the disturbing effect of Jupiter's gravitational field. The same effect is, apparently, accountable for the small size of Mars.

Generally, all objects related to the Earth group of planets can be arbitrarily divided into three pairs. The first pair, Mercury and the Moon, have a surface densely covered with craters which are traces from the epoch of formation of the planets. The second pair, Venus and Earth, can be thought of as "twins". And the third pair includes Mars and the asteroid belt, the objects that suffered most from their neighbor Jupiter during the formation epoch.

Study of the asteroids progressed significantly in the recent years. It has been found that the composition of asteroids differs within the belt. In its inner zone, the one that is closer to us, the prevailing substance is similar to that of common chondrites, the most widespread type of silicate meteorites. (Earth and Moon consist of a similar material, too.) The bright stone objects in this zone are referred to as S-asteroids. Toward the outer edge, dark objects called C-asteroids prevail. Their matter is similar to that of carbonaceous chondrites of types 1 and 2 (referred to as C1- and C2 type chondrites), which are encountered in the more simple meteorites composed of silicates and volatile compounds.

Thus, the differentiation of composition within the asteroid belt corroborates the notion of condensation of high-temperature compounds in the primary gas-and-dust cloud closer to the Sun, and that of low-temperature compounds in the more distant zones.

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\*But then the Moon with its mass 81 times less than that of Earth and 3.344 g/cm<sup>3</sup> average density can be included in the Earth group of planets.

Let us return now to our main subject, the Martian satellites. Their basic physical characteristics given in Table 1 demonstrate a striking similarity between both Phobos and Deimos and the asteroids, particularly, C-asteroids, in size, mass and density; the density of the Martian satellites, particularly Phobos, is very close to that of meteorites of types C1 and C2. It is very likely that Phobos and Deimos are indeed two small C-asteroids which in a way as yet got caught in orbits around Mars.

The rotation of Phobos and Deimos is synchronous with the planet, i.e., they always face Mars with the same side. The orbits of the Martian satellites are almost circular; the eccentricity being  $.015 \pm .001$  for Phobos and  $.0005 \pm .0003$  for Deimos. They are also practically in the same plane as Mars' equator, that of Phobos being tilted at  $1.02^\circ$  and Deimos  $1.82^\circ$ . Semi-major axes of the orbits are 9378.5 and 23,459 km and orbital periods 7h 39 min and 30h 21 min, respectively. Thus, Phobos, while revolving around Mars, moves faster than the daily rotation of the planet, and for a Martian observer it would rise in the west and set in the east.

Table 1. Physical Characteristics of the Martian Satellites

Characteristics	Phobos	Deimos
Mass, $\times 10^{18}$ g	$9.9 \pm 1.1$	$2.0 \pm 0.7$
Dimensions, km		
greatest	$27 \pm 1$	$16 \pm 2$
smallest	$19 \pm 1$	$11 \pm 1$
Density, g/cm <sup>3</sup>	$2.2 \pm 0.2$	$1.7 \pm 0.2$

It is interesting to note that Phobos is below and Deimos is above a stationary, or synchronous, orbit on which the angular velocity of the satellite revolution coincides with the angular velocity of rotation of the planet. Because of tidal friction, Phobos gradually comes closer to the planet, while Deimos very slowly moves away from it. According to some estimates, Phobos is expected to fall onto Mars in 30 to 70 million years. Considering that the age of the bodies in the Solar system is about 4.6 billion years, we should take the chance to observe Phobos in our times 25 pure coincidence.

This leads to the assumption that Mars could have had other satellites in the past.

This interesting problem will be dealt with in the following chapters; here we will discuss the evolution of the orbits of Phobos and Deimos which is a very complicated problem and is very important from the point of view of the origin of the Martian satellites. As we have stated earlier, they are very likely to be C-asteroids captured by Mars. Thus, a detailed study of Phobos and Deimos by means of space vehicles in the vicinity of Mars could be the first study of an extensive class of space objects present in the asteroid belt (as well as among the small satellites of the giant planets).

Phobos and Deimos will serve as examples to study the probable inner structure of objects of that type along with the structural formations on their surfaces. This gives scientists extensive and unique information on the origin of such bodies and the whole Solar system as well. Such are briefly the subjects with which we want to familiarize the reader.

In conclusion, it should be noted that the study of Phobos and Deimos has opened a new page in the study of the solar system. Until very recently these two tiny satellites were for us mere material points. Today we know their dimensions, mass, average density, and the structure of the surface. We know that they, apparently, belong to the C-asteroids, a very important and interesting type of primary objects in the Solar system. However, several fundamental problems related to the origin of these two satellites, their age, composition and structure still remain unsolved.

To solve these problems is very important for a general understanding of origin and evolution of the Solar system. This is why it is not impossible that the study of Phobos and Deimos will continue by landing space vehicles on their surface during this century. Prior to that, the Martian satellites will likely be studied in detail from fly-bys by space vehicles placed in orbit around Mars.

Landing of a space vehicle on the satellite surface will provide researchers with totally new possibilities. One can think, for example, of a direct analysis of the structure and ground composition, or of drilling in conjunction with a wide spectrum of geophysical experiments which will make it possible to construct models of their inner structure. Seismic experiments seem particularly promising in this regard. Finally, direct measurements of heat flow from the satellite interior can also provide valuable information.

Close fly-bys by space vehicles will greatly contribute to the study of Phobos and Deimos. Photographic atlases of the Martian satellites, maps of their surfaces, stereopanoramas of the total surface, a detailed study of their structure will make them more and more familiar to us. Supersensitive gradiometers on spacecraft will permit us to precisely determine the masses of the satellites and to determine the structure of their gravitational fields. Remote sensing of Phobos and Deimos by means of appropriate instruments seems also very promising in this case.

It is very likely that similar studies of asteroids from space vehicles will be done at the same time. Comparison of results obtained with direct observations of asteroids on the one hand, and Phobos and Deimos on the other, will help in solving many problems that currently face researchers.

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INTERPLANETARY SCIENCES

UDC 550.81:523.42

RESULTS OF STUDY OF SURFACE OF FIVE REGIONS ON VENUS BY BISTATIC RADAR  
METHOD

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 30 Jun 83) pp 895-905

KUCHERYAVENKOV, A.I., MILEKHIN, O.Ye., PAVELYEV, A.G. and YAKOVLEV, O.I.

[Abstract] A method for processing data from a bistatic radar was improved in order to obtain information on the surface of individual regions on Venus with a resolution substantially better than in the Pioneer-Venus experiment. The improved method made it possible to achieve a surface resolution of 5-20 km. In the bistatic radar observations made from "Venera-10" the planetary surface was irradiated by monochromatic radio waves with a wavelength 32 cm. The transmitter was aboard the vehicle and registry of the direct signal and the signal reflected from the surface was performed at a ground station. Movement of the mirror reflection point on the Venusian surface caused by satellite motion relative to the planet made it possible to study regions adjacent to the trajectories of motion of a mirror reflection point. Five regions were explored. The first four were in the southern hemisphere and the fifth was in the northern hemisphere. For the first four, satellite altitude was 1,500-2,000 km, whereas for the fifth it was 9,000 km. The area of the first four regions, in general, was 100 x 60 km, whereas for the fifth the area was 500 x 300 km. Surface resolution was dependent on spectral analysis resolution: for regions 1-4 -- 5-20 km, region 5 -- 30-80 km. The surface characteristics of each of the five regions are discussed in detail. The bistatic radar survey yielded much new information on the roughness, mean and local macroscale surface slopes in the five studied regions. The surface resolution for four regions was ~10 km and it was ~50 m for the fifth, the best ever achieved. Figures 8; references 8: 5 Russian, 3 Western.  
[61-5303]

UDC 523.042:523.42

POSSIBILITY OF SPECTROSCOPIC DETECTION OF OXYGEN IN LOWER VENUSIAN ATMOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 27 Jun 84) pp 812-815

KRASNOPOLO'SKIY, V.A.

[Abstract] The problem of determining molecular oxygen in the lower atmosphere of Venus is examined. Experimental data are limited to the gas chromatograph measurements by the descent modules of the Pioneer-Venus and the "Venera-13" and "Venera-14" and surface spectroscopic observations. It was found that the relative content of  $O_2$  was  $f_{O_2} = 44$  and 16 ppm at altitudes 52 and 42 km respectively and less than 0.3 ppm at 62-65 km. The presence of  $O_2$  and CO in approximately equal quantities of about 10 ppm in the lower atmosphere of Venus is possible only with violation of thermochemical and photochemical equilibrium. The detected quantities of molecular oxygen are mysterious and require confirmation by some method less sensitive to contaminations and local disturbances introduced by the descent module. The spectroscopic detection of  $O_2$  in the lower atmosphere is possible using lines of the band (0, 0) 7620 Å of the atmospheric system  $O_2$  ( $b^1\Sigma^+ - x^3\Sigma^-$ ). In order to detect  $O_2$  it is desirable to obtain a considerable increase in spectral resolution so that individual lines can be measured. For this purpose the possibilities of the Fabry-Perot interferometer are considered. This could be combined with a diffraction spectrometer. This spectrometer, with a resolution of 1 Å, can ensure a threshold of detection of molecular oxygen of 1 ppb in the case of a constant relative content of  $O_2$  in the entire atmosphere, 3 ppb in the case of presence of  $O_2$  only in the cloud layer. If the thresholds are increased, experiments can provide reliable data on the vertical profile of the concentration of molecular oxygen in the Venusian lower atmosphere. Figures 4; references 13: 8 Russian, 5 Western.

[31-5303]

UDC 621.317:523.43

MARTIAN MAGNETIC FIELD ACCORDING TO SIMULTANEOUS MEASUREMENTS IN PLANETARY MAGNETOSPHERE AND SOLAR WIND

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 16 May 84) pp 792-803

DOLGINOV, Sh. Sh., ZHUGOV, L.N. and SHKOL'NIKOVA, S.I.

[Abstract] The article gives the parameters of the Martian magnetic dipole on the basis of measurements from the "Mars-2" satellite on 23-24 February 1972. Although the experimental data have deficiencies

(the satellite was without triaxial orientation and the interrogation of the vehicle was infrequent) the magnetograms contain important information. This is because during the 35 hours of measurements the satellite twice reached pericenter on the daytime side and twice reached the region of the magnetic tail on the nighttime side. Simultaneously with the measurements from the "Mars-2" the magnetic field was measured from the high-apogee satellite "Mars-3" (with triaxial orientation) in the free solar wind. Changes in the dynamic pressure of the solar wind during the time of the measurements were simple. The combined data made it possible to determine field topology, which is compared with the field topology near Venus and a model of a "draped" magnetosphere corresponding to the observed interplanetary magnetic field. Proof is given that Mars has its own magnetic field with a magnetic moment  $M_M > 1.5 \cdot 10^{22}$  gauss.cm<sup>3</sup>, this constituting an effective obstacle to the solar wind. The strike of the magnetic tail was traced to  $8R_M$ . The problems involved in determining orientation of the dipole on the basis of observations in the tail at distances  $6-8R_M$  are discussed. On the assumption that the width of the Martian polar cap is  $\sim 45^\circ$  it is estimated that the magnetic tail of the Martian magnetosphere can extend to  $90R_M$ . The real obstacle to the solar wind near Mars is its magnetosphere, not its ionosphere. Near Mars there is an Earth-type, not a Venusian type of interaction with the solar wind. Figures 5, tables 1; references 23: 9 Russian, 14 Western.

[31-5303]

#### ROSSBY AUTOSOLITON

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 41, No 1, Jan 85 (manuscript received 12 Aug 84) pp 25-28

ANTIPOV, S.V., NEZLIN, M.V. and TRUBNIKOV, A.S., Atomoc Energy Institute imeni I.V. Kurchatov

[Abstract] A Rossby autosoliton, a new nonlinear physical feature, has been experimentally detected. This is a nonattenuating solitary rotating anticyclonic eddy which is evidently self-organizing in countercurrents in rotating shallow water. It can be interpreted as a stationary soliton model of the Great Red Spot of Jupiter, for the first time experimentally duplicated. This so-called autosoliton has three properties which distinguish it from the solitary geostrophic eddies already known. It is not subject to viscous attenuation and exists for an unlimited length of time. It is analogous to the global vortices in planetary atmospheres, being a solitary formation, not an element of a closed chain of eddies such as has been repeatedly observed in the ocean. No special source is required for its generation because it is formed as a result of nonlinear evolution of variable shallow-water countercurrents. The autosoliton was produced

in a laboratory apparatus, a container with a parabolic bottom profile, such as used in earlier eddy experiments. In this apparatus (28 cm in diameter) the working fluid, water in a layer 0.5 cm deep, was subjected to the effect of two countercurrents propagating along the "parallels" about the axis of the system. Relative to the container the currents were generated by the differential motion of two sectors of its bottom which rotated in opposite directions and entrained the fluid layers situated above them. The detailed description of the experiment indicates that the autosoliton is generated by the centrifugal instability of currents which arises when the inner part of the shallow water is rotated more rapidly than the periphery. Figures 2; references 9: 9 Russian, 2 Western.

[70-5303]

UDC 521.24

#### NATURE OF MEGACYCLES IN EVOLUTION OF EARTH, MARS AND MOON

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 280, No 5, Feb 85  
(manuscript received 22 May 84) pp 1204-1209

MILANOVSKIY, Ye. Ye., corresponding member, USSR Academy of Sciences, and NIKISHIN, A.M., Moscow State University imeni M.V. Lomonosov

[Abstract] A comparative analysis of the tectonic structure and development of earth group planets clearly suggests three major stages in their evolution: accretional, endogenous evolution and cessation of endogenous development and general cooling with a predominance of the influence of external factors. However, the endogenous evolution stage probably did not begin at the same time on different planets. On some, such as Mercury and Mars, it has already ended, whereas on others, such as the Earth and possibly Venus) it is still continuing. On different planets this stage differs considerably in duration and complexity, especially with respect to the number of main stages or megacycles of endogenous evolution. All this is made clear in individual examinations of megacycles on the Moon, Mars and Earth (in the greatest detail for the latter). The following generalizations are drawn for the e bodies. On all these planets the megacycles begin with bursts of tectonic and magmatic activity in both hemispheres, but this activity is then focused in one of them. The specific nature of the newly formed structures within the more active hemisphere is dependent on the intensity of the endogenous processes occurring in a particular megacycle, the capacity of asthenospheric or upper mantle matter for horizontal movement, viscosity and thickness of the lithosphere. If the intensity of these processes is small and the lithosphere is thick and broken by impacts, a system of marine basaltic depressions is formed. But if this intensity is relatively great, the asthenospheric matter is not capable of forming stable horizontal currents and the lithosphere is thin, a planetary oceanlike depression is formed. If the lithosphere is thick and solid a

planetary crust is formed. A whole series of other variants is possible (these are discussed). The megacycles in turn can be complicated by a finer internal cyclicity; the number of "special" cycles in the active hemisphere is greater than in the passive hemisphere. Megacycles end either with total cooling of the planet or with some pause in its activity or by an epoch of crustal cratonization, the latter being characteristic of the Earth. The final megacycle in crustal cratonization does not occur simultaneously over the entire Earth, appearing first in the passive hemisphere and then in the active hemisphere. With these and other generalizations taken into account, the authors outline a sequence of deep processes in individual stages of a megacycle for the Earth. Figures 1; references 12: 9 Russian, 3 Western.

[69-5303]

LIFE SCIENCES

BIOLOGICAL LIFE-SUPPORT SYSTEMS FOR LONG-DURATION SPACE FLIGHTS

Moscow IZVESTIYA in Russian 11 Feb 85 p 3

[Interview with Yevgeniy Yakovlevich Shepelev, Biomedical Problems Institute, USSR Ministry of Health, by I. Andreyev; date and place not specified: "Bread is Essential in Space Flight"]

[Text] Whether we newspapermen are responsible, or specialists say too little on the subject, nevertheless, the press discusses one subject, which one could call the most everyday subject, less frequently than other "space" themes: how one drinks in space, what one drinks, if a distant interplanetary flight is to be made for a year or two! How does one deal with what science delicately calls the products of man's vital functions? Finally, what does one breathe in a little man-made shell millions and millions of kilometers from the earth!

"In each case the answer is not on the classical principle 'I take everything with me', " says my interviewee Yevgeniy Yakovlevich Shepelev, doctor of medical sciences, specialist at the Biomedical Problems Institute, USSR Ministry of Health. "It was necessary to discard that idea long before the flights of Soviet cosmonauts which established records for duration. In other words, it is no longer possible to store everything that is needed in orbit, air, food and water, not to mention fuel, spare parts for instruments, and the like. Even today, when we are still not flying into distant space, there is no way to get by without regular 'reinforcement' of orbital expeditions by means of automatic ships."

"The problems inevitably arising in connection with extremely long interplanetary flights were dealt with already at the end of the last century by K. E. Tsiolkovskiy. He saw a biological origin for the manned medium in spaceships of the future. In 1915 another pioneer of Soviet cosmonautics, F. A. Tsander, cultivated plants nourished with the products of man's vital functions on charcoal."

"I do not think that there are alternatives for human biological life support systems on a prolonged space flight. Nature itself, organizing its cycles in such a way that in the course of each of them some living organisms or the products of their vital functions serve as food for others, set the pattern for this. And here is another argument in favor of systems simulating the natural processes of biological reproduction: the necessary quality of the atmosphere. Today it is an artificial medium, a sort of ersatz of real terrestrial air. In order to bring it to a proper condition it is necessary to

know everything about the natural atmosphere, about its most insignificant constituents, about the contributions made by all possible plant and microbial populations, about much about which no one knows anything today."

Question: "Then it appears that it is necessary to duplicate 'I don't know exactly what'?"

Answer: "Precisely! Only not by ourselves. Assume that nature, recreated in space flight, acts the same as it has since time immemorial on our own planet. But one step at a time. First I will introduce the 'actors' in this model of a life-generating terrestrial cycle. The role of the chief actor, in any case today and in the foreseeable future, will be played by unicellular algae, Chlorella: it rapidly multiplies, produces oxygen beautifully under the influence of the sun's rays, does not release toxic substances, is nutritive, is not capricious, and what is important, is extremely suitable for systems with a minimum quantity of nonconsumable wastes. The cycling of matter occurring in the closed space of a future spaceship also begins with Chlorella. The picture is as follows: actively multiplying, Chlorella enriches the atmosphere with oxygen, absorbs the respiratory products released by the crew, accumulates mass suitable for reworking into food products and assimilates the mineralized products of man's vital functions. This, it goes without saying, is only a scheme -- it is not so simple to realize it because Chlorella alone cannot cope with all the operations in the continuous chain of transformations of matter. In any stage it can be assisted, shall we say, by microorganisms mineralizing the liquid products of man's vital functions."

"In conformity to such a very simple scheme specialists in the USSR have developed and experimentally studied several 'man-Chlorella-microorganism' models in which there is regeneration of the atmosphere, water and the utilization of volatile emanations accompanying the decomposition of organic wastes."

"Due to the small air volume allocated to one person and the small quantity of water the substances in such a system are transformed very rapidly one into another. In a single month there were 15 cycles of regeneration of oxygen and almost two of water. Oxygen is completely returned for consumption, water -- in a volume nine-tenths the daily consumption. The food in these experiments was of 'external' origin, but 8% of its daily consumption could be supplied."

"An important result of the experiments was the finding that algae and the microorganisms accompanying them can cope with purification of the atmosphere from volatile admixtures. This facilitates operation of the filters used for this same purpose and maintains useful biologically active substances in the regenerated air."

Question: "The Chlorella 'bread-winner' performs many functions, its 'responsibilities' are very great: should anything go amiss in the mechanism of its reproduction, then..."

Answer: "Yes, far from the earth there is no way to get the foods to which we are accustomed or anything like it. In actuality, how will the 'biological reactor', once triggered, behave? Will it not yield an abnormal generation of

the crop with a very short reproduction cycle? In short, will the unending process of biological regeneration not go out of equilibrium, if, for example, the Chlorella is overheated, or, vice versa, is overcooled?"

"No, such a thing has never occurred, even under emergency conditions. Despite partially damaged cells the crop was self-restored; it was protected from genetic 'drift' by the mechanism of stabilizing selection. The following fact is eloquent: one and the same strain of Chlorella was in use for 15 years and exhibited excellent genetic stability."

"It is no accident that the tested systems were called models. They reproduce, to be sure, only a simplified version of future systems; they are used to check the main, fundamental schemes. It goes without saying that no one intends to doom the interplanetary cosmonaut to a strictly algae 'diet.' Their ration will also include vegetables, eggs, milk and probably meat which are reproducible in the life support system. Finally, some part of the food will be taken with them from the earth."

"Having obtained stable results with models using Chlorella and other unicellular algae, Soviet researchers proceeded to experiments with higher plants. For example, one of the 'man-higher plants' models was of much greater size. In its closed space -- more than 300 cubic meters -- there was a crew of three men. In one of the four compartments there was a greenhouse in which wheat was sown, and in a second, a 'kitchen garden' planted with beets, carrots, turnips, radishes, cucumbers, onions and greens..."

"Without delving into the technical and 'agricultural' details, it can be said that the total fraction of edible biomass from the 'cornfield' and the 'kitchen garden' was more than 30%. But if food is prepared not only from the 'tops,' but also the 'roots,' for example, if the juice were to be pressed out from the inedible wastes of higher plants, the so-called closure of the food system can be increased. But even without such a reserve such an important index increases with a transition from Chlorella to higher plants by from 8 to 201."

Question: "Is it possible that Chlorella is not necessary at all?"

Answer: "No, there is no way to get by without it. Not only does it cope with a great many useful tasks, it is assigned the role of feed for animals giving meat, milk and eggs. That is the great promise of biological systems, that they reproduce the environment surrounding us in miniature, with its numerous interspecies food links. The model is the more perfect the fewer the unoccupied, 'vacant' ecological niches which are present. Our task is to fill them in the most natural way possible, to find the necessary and adequate degree of species, and most importantly, functional makeup of each link. This governs the completeness of the closed cycling of matter in the system, its autonomy and stability."

Question: "Who among our 'lesser brothers' will be the first to settle in space flight?"

Answer: "The first inhabitant of a space farm will probably be quails: they have an excellent index of specific productivity per unit of mass and the

quantity of feed expended on maintenance. Experiments with the incubation of quail eggs have already been carried out on biological satellites. Initially people will use so-called secondary products, or expressed more simply, the eggs. It is easier to store and use them under the confined conditions of a spaceship. A Chlorella culture has passed the first tests of weightlessness and other 'extraterrestrial' factors. The next steps will be the checking of other elements of the system under real conditions and the perfecting of the on-board technology for the cultivation of individual representatives of the plant and animal worlds, whole biological communities."

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CSO: 1866/75

LIFE SCIENCES

ARCHITECT DISCUSSES SPACE HABITAT DESIGNS

Moscow PRAVDA in Russian 4 Dec 84 p 3

[Article by S. Ziganenko: "A Type of Occupation: Astroarchitecture"]

[Text] On a scrap of paper try to sketch the layout of a spaceship. Without doubt its living compartment will be quite terrestrial: the hand, intuitively, will put the table, chairs, sleeping places, kitchen and other accessories of a dwelling on the floor. A very simple test, but how graphically does it reveal our age-long concepts concerning "up" and "down"!

Today there are not many earthlings who can free themselves of these concepts. But specialists in the field of extraterrestrial architecture, astroarchitects, have finally "broken" away from weight, from gravity. One of them is V. I. Loktev, candidate of architecture, senior scientific specialist at the All-Union Scientific Research Institute of Art Studies, USSR Ministry of Culture.

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A spaceship, and especially the orbital station of our day, is no longer merely a transport vehicle. It is a home in which people live for months, and tomorrow... An expedition to Mars alone will take 3-4 years and most of this time will be spent by the cosmonauts without emerging from their flying home.

But what should it be like? Specialists are already convinced that terrestrial yardsticks are ill-suited for space. As often happens, they were not immediately convinced, but only after going through a rather long process of trial and error. The weight of tradition is heavy and people cannot immediately break away from what has seemed the immutable truth.

Only relatively recently, during the designing of the "Salyut-4" station, specialists had recourse to an idea paradoxical by terrestrial standards: they installed a bicycle-type ergometer on the "ceiling."

The astronaut Charles Conrad, who participated in designing of the "Apollo" lunar cabin, with great difficulty was able to convince designers that there was no need at all for putting a chair or stool at the control panel. It is sufficient to have restraints for the feet: after all, it is no easier to sit in a state of weightlessness than it is to stand or hover.

And here's what happened: people from the "outside" came to the assistance of designers, specialists in the field of space medicine and psychology, people with the know-how to organize space. These are architects, or to be more precise, astroarchitects.

"What's this that I'm an astroarchitect!" protests Vyacheslav Ivanovich Loktev. "True, I studied architecture. But in space terrestrial experience is scarcely useful. So that in this field for the time being we are all novices..."

Which, to be sure, is true. But note this: it only seems that something new begins from "nothing," in a vacuum. A teacher at the Kaluga secondary school, K. E. Tsiolkovskiy, devised designs not only of the first rockets, but also "settlements in the ether." At approximately the same time the German H. Nuhr-dung proposed that a gigantic "ring-shaped doughnut" be suspended over the equator in a stationary orbit at an altitude of 36,000 km. This would be a toroidal space station, a station with a configuration entirely logical even from the point of view of present-day specialists. The Frenchman Pierre Sech-elle devised an "aerial city" which would encircle the earth in 24 hours. And all this, you will note, was at the beginning of the century, when rockets were suitable, at best, for fireworks.

Real, and not imaginary space flights, still further activated creative ideas.

"Somewhat unexpectedly, even for myself, I began to collect materials which might be suitable for the developers of future space settlements," recalls Loktev.

Vyacheslav Ivancvich then, 17 years ago, proceeded along a course, which I would say, is logical for people of his profession. He began to collect materials showing how terrestrial architects would overcome gravity.

"Gothic, baroque... Whole schools, architectural directions, have striven to make buildings as light as possible, at least visually," says Loktev. "The first half of our century was unusually rich in this respect. The architects of the young Soviet republic, despite destruction and starvation, created projects, one more bold than the last. If we were to recall the well-known expression that architecture is music which has 'hardened,' in this case we would have chords casting a challenge to the heavens..."

Specialists recall without difficulty, for example, the projects for 'falling houses,' soaring cities, which should consist of buildings suspended from a steel grid... All this represents a development of ideas by the Soviet architect G. Borisovskiy. There is even a term which he introduced then -- 'suspended architecture'."

"But all these are projects directed to overcoming terrestrial gravity," says Vyacheslav Ivanovich in continuing his story. "Today we are talking about a world which is completely without gravity. Where necessary, it must be created artificially. What would cities be like in this world? For the time being no one knows. Although there are already more than a few preliminary projects, it is evident that the new living conditions require not only new

constructions, but also new forms. At present it seems to us that the most rational forms for space are a torus, a cylinder and a sphere, that is, the figures having the minimum surface with the maximum volume. But naked rationalism is good only at the very beginning, when the technical possibilities rigorously limit the weight of the construction and its size. But in the future, indeed, we do not plan to exist in space, but to live! And the new form of life will evidently require new architectural forms. Precisely what? It could be this, it could be that..."

Loktev points to models, sketches and diagrams. Extremely unusual forms, spiraling-band constructions, making transitions through the impossible; today they seem strange and unrealizable. But tomorrow?

"In all earlier projects it seemed mandatory that artificial gravity be created by the rotation of cylinders about their own axes," continues Vyacheslav Ivanovich. "But is artificial gravity essential? Cosmonauts already today live in a world without gravity, and as Academician O. G. Gazenko postulates, there is nothing fundamentally impossible in biological adaptation to a constant existence under weightlessness conditions. And under such conditions would a chair and bed be necessary? What would a desk be like? After all, do not forget that we are talking about a world where apples do not fall, but float through the cabin, like soap bubbles, where it is possible to sleep on the ceiling, but where it is impossible to wash up with water from a tap, as everyone on the earth is accustomed to..."

During the time of orbital flight the cosmonauts use other groups of muscles than they use on earth. The people there require different motor skills. For example, the cosmonaut V. I. Sevast'yanov brought from space as a memento a pair of wool socks worn through at the little toes. As it appeared, it was most convenient for him to use his little toes for pushing away for movement within the station. A different character of muscular efforts can also give rise to different psychological emotions. And this means that what is customary and logical for the "sons and daughters of the ether" may be constructions which will be completely unfamiliar to us, and possibly may be forms beyond our comprehension...

The vision of the artist at times outpaces the boldest predictions of the scientist. Recall that the famed lines of Valeriy Bryusov: "possibly these electrons are worlds where there are five continents" appeared before the logical proof of the possibility of the existence of such a world by the mathematicians Fridman and Matkov.

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CSO: 1866/64

COMMENTS ON BIOLOGICAL RESEARCH ON 'COSMOS-1667'

Moscow KOMSOMOLSKAYA PRAVDA in Russian 13 Jul 85 p 4

[Article by S. Leskov]

[Abstract] The article records comments by personnel of the Institute of Medical-Biological Problems regarding neurophysiological and other studies of biological specimens on board the satellite "Cosmos-1667". The main purpose of these experiments is to learn more about mechanisms of adaptation to zero gravity, according to Doctor of Medical Sciences Ye. Il'in, one of the directors of the scientific program for this mission. The animals carried by the satellite included two monkeys of the macaque genus, which were named "Vernyy" and "Gordyy".

Doctor of Medical Sciences I. Kozlovskaya compared the goals of the mission with those of the biological satellite "Cosmos-1514", which also carried macaque monkeys. Unique results of the earlier mission included the determination of mechanisms of the effects of weightlessness on the excitability of the vestibular apparatus.

Academician O. Gazeiko, director of the institute, commented on the advantages of using animals in certain types of space experiments. Studies of processes in the cerebral cortex, for example, can be made with the aid of implanted electrodes in the animals. The monkeys on "Cosmos-1667" also had supersensitive transducers implanted in their carotid arteries, to measure the animals' circulation rates and arterial pressures. Among the other animals carried by the satellite were 10 newts. A foot had been amputated and an eye lens removed from each of these creatures. The purpose of this is to shed light on the mechanism of regeneration of living cells in conditions of zero gravity, Gazeiko explained. Results of these experiments will be important for determining the rate at which cosmonauts' injuries can heal.

FTD/SNAP  
CSO: 1866/116

LIFE SCIENCES

GAZENKO ON RESULTS FROM 'COSMOS-1667'

Moscow KOMSOMOLSKAYA PRAVDA in Russian 20 Jul 85 p 1

[Article by S. Leskov]

[Abstract] The short article records comments of academician O. Gazeiko, director of the Institute of Medical-Biological Problems, and Doctor of Medical Sciences Ye. Ilin on the results of the recent mission of the biological satellite "Cosmos-1667".

Ilin reported that the two macaque monkeys and other biological specimens carried by the satellite were in excellent condition following the flight. On the second day of the mission, the monkeys had adapted to conditions of weightlessness, and their motor activity was restored. Mention is also made of results of an original experiment with newts from which eye lenses had been removed and extremities amputated before the launch. In space, the newts began to form new eye lenses, and extremities which had been amputated began to grow. Initial observations are said to indicate that regeneration of lost tissues proceeded just as rapidly in the animals on board the satellite as in a control group on the ground. A post-flight series of experiments with the "Cosmos-1667" specimens is scheduled.

A photograph is given showing two monkeys strapped into chairs of the type designed for biological satellites.

FTD/SNAP  
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LIFE SCIENCES

UDC 577.3

ENERGY EXCHANGE OF PLANTS UNDER WEIGHTLESSNESS CONDITIONS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 280, No 2, Jan 85  
(manuscript received 7 May 84) pp 509-512

TAIRBEKOV, M.G. and DEVYATKO, A.V. Institute of Biomedical Problems,  
Moscow

[Abstract] The "Cosmos-1514" biosatellite functioned in circumterrestrial orbit during the period 14-19 December 1983, during which the "Energy Exchange" (Energoobmen) experiment was carried out. The "Biokalorimetr" instrument was used; it is illustrated in Fig. 1 in the text (13 components identified). The instrument makes measurements in the range from 0 to 100 mW with a total error of 2%. There are three elements: working chambers unit, control-monitoring unit, pneumatic unit. These are connected by pneumatic tubes and cables. The calorimeter is of the differential and diathermal type. The two cells contain semiconductor thermoelectric temperature gages. A constant heat release in one of the cells causes the appearance of a temperature difference across the junctions in this cell proportional to the intensity of heat release. The temperature difference is transformed into an emf measured by a secondary measurement instrument. Each of the working chambers (cells) has a volume of 500 cm<sup>3</sup>. One holds the biological material to be studied and the other a simulator of this material. Periodic ventilation takes place. Chamber temperature is maintained at 26.5+0.1°C. The studied material was corn sprouts (seeds of the Sterling corn variety, harvest of 1982). Seed pre-processing is described. Seeds were placed at the bottom of the working chamber, 50 ml of water was added and the cell sealed. Dry seeds in a polyethylene packet were placed in the other cell and 50 ml of water was added. Measurements began 14-16 hours after the instrument began to operate. At the landing site the sprouts were photographed and subjected to morphometric analysis in a field laboratory. All seeds grew under weightlessness conditions. The results are represented in Fig. 2 in the text: dynamics of heat release of sprouting seeds in flight (experimental variant) and in the two control variants. All three curves have an identical shape. It is concluded that spaceflight factors, including weightlessness, exerted no influence on the principal processes transpiring in the plant organism with the expenditure of energy. Figures 2; references 10: 8 Russian, 2 Western.  
[65-5303]

SPACE ENGINEERING

UDC 629.7.1.30.82

STABILITY OF STATIONARY MOTIONS OF TWO TETHERED BODIES IN ORBIT UNDER  
INFLUENCE OF GRAVITATIONAL AND AERODYNAMIC FORCES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 5, Sep-Oct 84  
(manuscript received 5 May 83) pp 675-682

LEVIN, Ye. M.

[Abstract] The motion of two tethered bodies in a low circumterrestrial orbit affords enormous possibilities for carrying out various types of geophysical research which are impossible from a single satellite. The probe, attached to a satellite by a long tether, can move in lower atmospheric layers where satellite motion is precluded to atmospheric drag. The article analyzes motion of two tethered bodies in a geocentric orbit. The satellite moves in a circular orbit at an altitude of 200-250 km above the earth's surface and the probe, joined to the satellite by a thin strand, moves at an altitude of 100-150 km. In investigating this system the probe is regarded as a material point and the cable is considered to be an extensible strand with mass. The aerodynamic forces operative on the probe and cable are calculated. The stationary motions of the system constitute uniform revolution about the earth as a solid body. The stability of these stationary motions is investigated. It is shown that the restrictions imposed on the cable parameters by the stability requirement are more rigorous than the restrictions imposed on cable strength. Figures 3; references 15: 9 Russian, 6 Western.

[31-5303]

EXPERIMENTAL CHECKING OF MATHEMATICAL MODEL OF EDDY CURRENTS IN ACTUATING  
COMPONENTS OF SYSTEMS FOR MAGNETIC ORIENTATION OF ARTIFICIAL EARTH  
SATELLITES AND SPACECRAFT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 6, Nov-Dec 84  
(manuscript received 14 Jun 83) pp 945-947

LEBEDEV, V.G., RABINOVICH, B.I., ASHKINAZI, R.I. and VIKTOROV, S.V.

[Abstract] Mathematical models describing the dynamics of an electromagnet as an actuating element in a stabilization system, with allowance for conductivity of the ferromagnetic core, in the form of integro-differential equations of the Volterra type, were given by B.I. Rabinovich, et al. in KOSMICH. ISSLED., Vol 22, No 5, 1984. This article is devoted to a close examination of one of these models (numbered (2.15) in the mentioned source). The model considered is represented as follows:

$$LI + LJ + RI = U, \quad LI + LJ + K \int_{-\infty}^t \frac{j(\tau) d\tau}{t - \tau} = 0$$

where  $L$  is the coil self-induction coefficient,  $R$  is coil winding resistance,  $K$  is a coefficient characterizing energy scattering within the core,  $I$  is the current in the electromagnet coil,  $J$  is a generalized coordinate corresponding to eddy currents in the core,  $U$  is the controlling voltage across the winding. The adequacy of this mathematical model was checked experimentally. Methods were developed to determine the  $L$  and  $K$  parameters. The model was compared with other possible models. The adequacy test was the degree of deviation of parameters of the mathematical model from some constant values with a change in frequency of the controlling voltage  $U$  in a broad (0-100 Hz) frequency range. Comparison was with the "traditional" model and a model describing eddy currents in a core using a short-circuited loop inductively coupled to the coil. The computations presented here indicate that for practical purposes the mathematical model (2.15) is a correct representation in the entire investigated frequency range. Figures 3; references: 1 Russian.

[61-5303]

UDC 629.783:(656.61.052:527.621)

## DETERMINING QUASI-REAL-TIME LOCATION OF SHIPS USING GEOSTATIONARY NAVIGATIONAL SATELLITES

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 6, No 1, Jan-Feb 85  
(manuscript received 18 Jun 84) pp 96-101

[Article by V. E. Abdullayev, K. Kh. Ismalilov, V. N. Vintayev and G. A. Sosunov, Institute of Space Investigations of Natural Resources]

[Text] Extensive work is being carried out and enormous funds are being expended on development of special space systems (Timation, Transit, Navstar, 621B) [1], which are based on the Doppler method of determining the location of ships from satellites moving along mid-altitude circular orbits, and which have good precision characteristics, to meet modern navigational requirements in precision, global coverage and speed, regardless of the time and climatic conditions of navigation. However, they all have a common deficiency--considerable time between observations.

Based on the common trend in development of satellite systems of the last few years, one can assume the feasibility of developing a navigational system, consisting of satellites in a geostationary orbit, the constancy of coordinates and simplicity of observation of which make it possible to achieve a high saving due to use of the undoubtedly promising passive long-range method of determining the location of an object on the earth's surface. The systems, the basis of which is the method of determining navigational data, are founded on the noninterrogation principle in which the navigational parameters are determined on a mobile object by comparing the signals received from the satellite to the signals of onboard oscillators.

Information about the coordinates from a minimum of two satellites in the line-of-sight zone is required for a ship to determine its location with the given method. Then, by knowing the orbital altitude of the satellites  $h$  (Figure 1) and also the coordinates of points A and B under them, one can easily find C--the location of the ship. The long-range information obtained in this manner is rather easily converted to the position coordinates of a moving maritime object. At the same time, the question of developing special high-speed computers and also of working out an algorithm for computations

that permit data processing and output of the results at a speed exceeding the speed of the most modern ships arises in solving the given problem under real conditions.

Consideration of this problem must begin with selection of the optimal algorithm for conversion of long-range information to the position data of the ship at any point of the ocean in the geocentric coordinate system with subsequent conversion to an ellipsoidal (geographic) coordinate system.

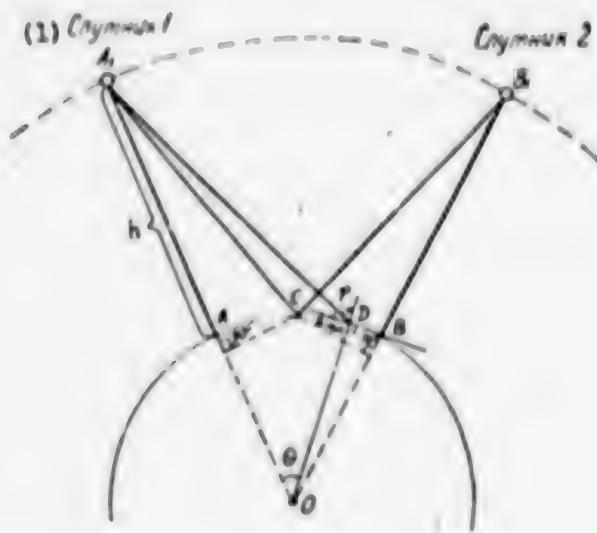


Figure 1

Key:

1. Satellite

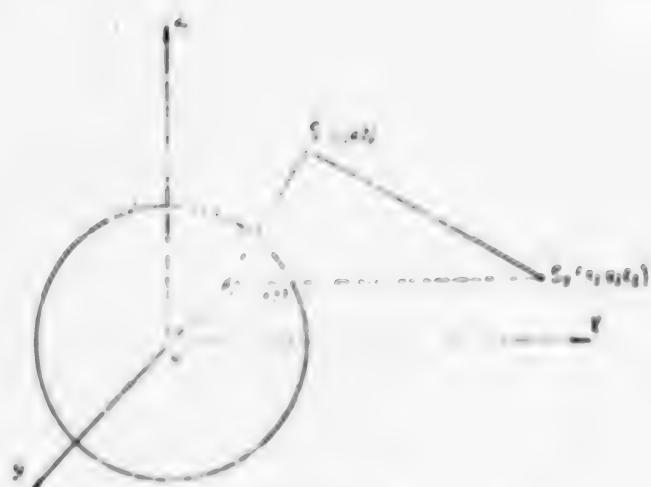


Figure 2

We will proceed in the solution on the basis that the coordinates of two satellites— $S_1(X_1, Y_1, Z_1)$  and  $S_2(X_2, Y_2, Z_2)$ , as is presented in Figure 2, are given in the geocentric coordinate system.

The problem reduces to determining the coordinates of point M, the distances of which to satellites  $S_1$  and  $S_2$  are equal to  $R_1$  and  $R_2$ , respectively. In the discussions, the earth with some assumption is taken as a sphere with center at point O and with radius of  $R = 6,588.96$  km. Considering the geocentric coordinate system (Figure 2), where the center of the earth coincides with the origin of coordinates, we write straight lines passing in space through points M and  $S_1$ , M and  $S_2$ :

$$(X - X_1)^2 + (Y - Y_1)^2 + (Z - Z_1)^2 = R_1^2 \quad (1)$$

$$(X - X_2)^2 + (Y - Y_2)^2 + (Z - Z_2)^2 = R_2^2 \quad (2)$$

the equation of a spheroid of rotation will be

$$X^2 + Y^2 + Z^2 = R^2, \quad (3)$$

where R is the earth's radius. Thus, to solve the postulated problem, one must solve system of equations (1), (2) and (3) with three unknowns X, Y and Z

After simple transformations, we represent system of equations (1), (2) and (3) in the following manner:

$$\left. \begin{array}{l} XX_1 + YY_1 + ZZ_1 = K_1, \\ XX_2 + YY_2 + ZZ_2 = K_2, \\ X^2 + Y^2 + Z^2 = R^2, \end{array} \right\} \quad (4)$$

Here

$$K_1 = \frac{R^2 - R_1^2 + X_1^2 + Y_1^2 + Z_1^2}{2},$$

$$K_2 = \frac{R^2 - R_2^2 + X_2^2 + Y_2^2 + Z_2^2}{2}.$$

Expressions (4) can easily be represented in the form:

$$\left. \begin{array}{l} X^2 + Y^2 + Z^2 = R^2, \\ X = \frac{Y_2 K_1 - Y_1 K_2}{X_1 Y_2 - X_2 Y_1} - \frac{Y_2 K_1 - Y_1 K_2}{X_1 Y_2 - X_2 Y_1} Z, \\ Y = \frac{X_2 K_1 - X_1 K_2}{Y_1 X_2 - Y_2 X_1} - \frac{Z_1 X_2 - Z_2 X_1}{Y_1 X_2 - Y_2 X_1} Z. \end{array} \right\} \quad (5)$$

## Introducing the notations

$$A_0 = \frac{Y_1 K_1 - Y_2 K_2}{X_1 Y_2 - X_2 Y_1}, \quad B_0 = \frac{Y_1 K_1 - Y_2 K_2}{X_1 Y_2 - X_2 Y_1},$$

$$A_1 = \frac{X_1 K_1 - X_2 K_2}{Y_1 X_2 - Y_2 X_1}, \quad B_1 = \frac{X_1 X_2 - X_2 X_1}{Y_1 X_2 - Y_2 X_1},$$

we find (5) in different form:

$$\left. \begin{array}{l} X^2 + Y^2 + Z^2 = R^2, \\ X = A_0 + B_0 Z, \\ Y = A_1 - B_1 Z. \end{array} \right\} \quad (6)$$

We then substitute the values of X and Y into the equation of a spheroid of rotation:

$$(B_1^2 + B_0^2 + 1)Z - (2A_1 B_1 - 2A_0 B_0)Z + (A_1^2 + A_0^2 - R^2) = 0$$

and, taking notations  $C_2$ ,  $C_1$  and  $C_0$  into account, we find the quadratic equation with respect to Z:

$$C_2 Z^2 - C_1 Z + C_0 = 0, \quad (7)$$

where  $C_2 = B_1^2 + B_0^2 + 1$ ,  $C_1 = 2A_1 B_1 - 2A_0 B_0$ ,  $C_0 = A_1^2 + A_0^2 - R^2$ .

The roots of equation (7) are equal to, respectively:

$$\mathcal{Z} = C_1 \pm \sqrt{C_1^2 - 4C_2 C_0}, \quad Z_1 = \frac{C_1 - \sqrt{C_1^2 - 4C_2 C_0}}{2C_2}, \quad Z_2 = \frac{C_1 + \sqrt{C_1^2 - 4C_2 C_0}}{2C_2}.$$

Thus, one can find the values of X and Y from system of equations (6), which are described by the expressions below:

$$X_1 = A_0 + B_0 \left( \frac{C_1 - \sqrt{C_1^2 - 4C_2 C_0}}{2C_2} \right), \quad X_2 = A_0 + B_0 \left( \frac{C_1 + \sqrt{C_1^2 - 4C_2 C_0}}{2C_2} \right),$$

$$Y_1 = A_1 - B_1 \left( \frac{C_1 - \sqrt{C_1^2 - 4C_2 C_0}}{2C_2} \right), \quad Y_2 = A_1 - B_1 \left( \frac{C_1 + \sqrt{C_1^2 - 4C_2 C_0}}{2C_2} \right).$$

Thus, we found two coordinates of point M:  $M_1 (X_1, Y_1, Z_1)$  and  $M_2 (X_2, Y_2, Z_2)$  and taking the presence of information about the approximate location of the desired point M into account (northern or southern hemisphere), one of the coordinates is eliminated.

The computer should then execute the program for converting from geocentric to ellipsoidal coordinates according to the following expressions:

longitude

$$L = \operatorname{arc} \operatorname{tg} \frac{y}{x}, \quad (8)$$

latitude

$$B = \operatorname{arc} \operatorname{tg} \frac{z \cdot \sin L}{y - \frac{(a^2 - R^2) \sin L}{\sqrt{a^2 + R^2 \operatorname{tg} B}}}. \quad (9)$$

Here  $a = 6,356.83$  km is the earth's radius in the polar plane and  $R = 6,378.245$  km is the earth's radius in the equatorial plane.

The given algorithm for computations was realized on a YeS-1022 computer. Without regard to operation of the peripheral devices, the computer expended 1.5 minutes on the given computations, which does not meet the imposed requirements. Fulfillment of these requirements can be provided by designing special processors in which the most laborious arithmetic operation will be that of solving transcendental equation (9). A special processor that determines the coordinates of the ship should realize parallel-serial combination of computer operations. The most acceptable for this case is pipeline organization of the processor, consisting of two sections: calculation of equation (8) and solution of equation (9).

The hardware makeup of the first section of the processor is the combination of adders, subtraction and division units, square-law generators and functional converters based on digital logic microcircuit and ROM elements. In this case the functions of the units are realized on a tabular basis. The functional converters are based only on read-only memory and are designed for special computations of direct and antitrigonometric functions and the values of square roots. The cycle of incoming data and obtaining results in the first section when using TTL [transistor-transistor logic] microcircuits reduces to 80 ns without resorting to direct methods of executing the computations in parallel.

The number of sequential steps of the iteration process in solution of equation (9), which we rewrite in general form:

$$B = f(B).$$

must primarily be estimated to construct the block diagram of the second section of the special processor.

If no fewer than  $N$  steps are required for iterative solution of the equation with given absolute error  $\epsilon$ , then, to implement the computation pipeline requires  $N$  units for verification of the condition

$$|B_n - B_{n-1}| < \epsilon$$

and  $N$  units that realize the linear function  $F(f)$ , which determines the next value of  $B_n$  from the preceding value  $B_{n-1}$ :

$$B_n = F(B_{n-1}, f).$$

where  $F$  determines the method of constructing the iterative solution of the equation. A block diagram of this pipeline appears in the form of a chain (Figure 3).

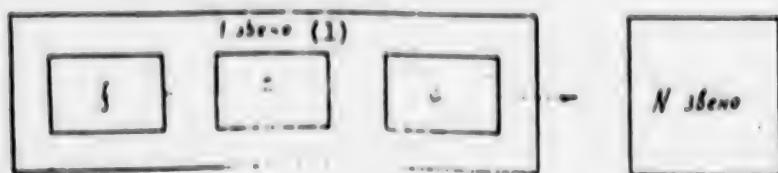


Figure 3.  $f$ --unit for computation of  $f(B)$ ;  $F$ --unit for computation of the expression  $F (f, B)$ ;  $\epsilon$ --unit for estimation of error and making the decision to continue the computations

Key:

1. Section

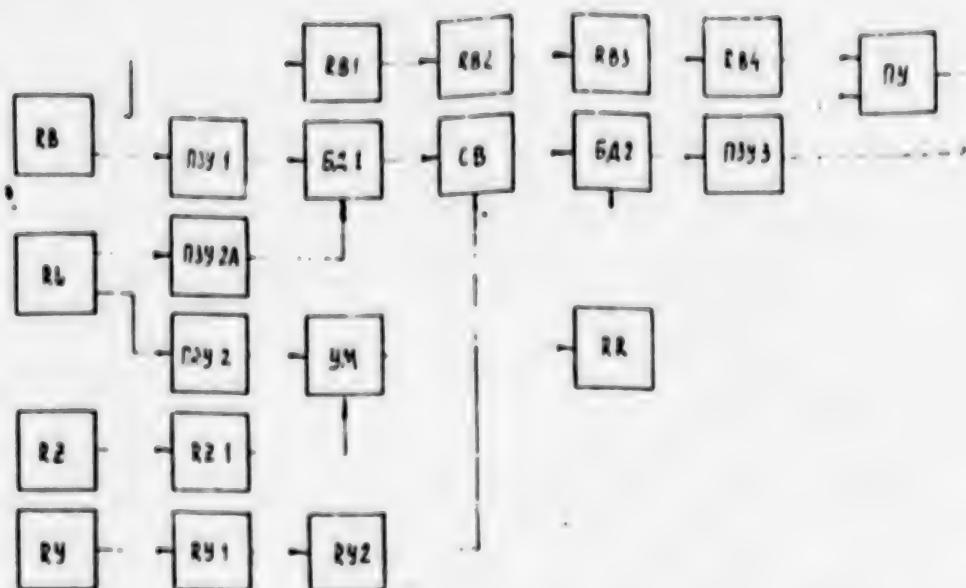


Figure 4. RB--storage register for input value  $B$ ; RB1-RB4--delay registers for operand  $B$  in circuit for verification of condition  $|B_i - B_{ii}| < \epsilon$ ; ПЗУ1--table of values  $\sqrt{a^2 + R^2} \sin B$ , arranged by addresses set equal to  $B$ ; БД1--division block; СВ--calculator-adder; БД2--division block; ПЗУ3--read-only memory for functions arctg; ПУ--unit for preliminary verification of condition  $|B_i - B_{ii}| < \epsilon$ ; RL--register for input value  $L$ ; ПЗУ 2A--read-only memory for values  $(a^2 - R^2) \sin L$ ; ПЗУ2--read-only memory for values  $\sin L$ ; УМ--multiplication circuit; RR--delay register for intermediate result; RZ--storage register for input value; RZ1--delay register for input value; RY--register for input value; RY1, RY2--delay registers for input value

If  $T$  is the total time allowed for solution of equation (9) and if the performance of the section is characterized by time  $T/N$ , then the block diagram of the pipeline will consist of a single section operating sequentially during each step. The hardware composition of the computation unit and  $F(f)$  and their structure are similar to those in the first section of the special processor, while a block diagram of the unit for computation of  $f$  is shown in Figure 4.

Registers  $RZ$ ,  $RY$  and  $RL$  in joining the computer units into a chain are connected through delays with the corresponding registers of the subsequent unit for computation of  $f$ . The use of the Mueller iteration method for solving equation (9) yields  $N \leq 15$  at accuracy of computations of  $10^{-3}$ . The total operating time of the second section of the special processor, realized on TTL microcircuits, is not more than 12 ms with cycle of incoming data up to 80 ns.

Thus, the special processor with pipeline organization of both the computer modules themselves and of the entire structure as a whole, proposed in this article reduces the time required to solve the computation problem from 1.5 min to 2 ms, with regard to the time required for auxiliary computations carried out in the first section of the special processor (80 ns). The total operating time of the conveyor from receipt of input data to output of the result is 2 ms.

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CSO: 1866/91

SPACE APPLICATIONS

UDC 621.396.98:629.783

ORGANIZATION OF SPACE NAVIGATION SYSTEM BASED ON USE OF GEOSTATIONARY SATELLITES

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNI-CHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 5, No 2, Mar-Apr 84 (manuscript received 19 Dec 83) pp 144-149

[Article by V. E. Abdullayev, Space Research Scientific-Production Association, Azerbaijan Academy of Sciences]

[Text] The modern navigation problem is inseparably related to the need for constant and operational support of the navigational personnel with meteorological, navigational and other types of information which could not possibly be provided without use of radio communications. The determination of a ship's position by such fundamental methods as observation of celestial bodies, the use of every possible radioelectronic and radar apparatus, is well known and has been developed in the form of an independent science called marine astronomy. However, with the appearance of present-day requirements, taking into account the high speeds of modern ships when there is a need at all times for reliable information on their position with an accuracy to a meter, all known marine astronomy methods are becoming greatly outmoded. Space navigation systems based on the Doppler method for determining the position of a ship by satellites moving in different circular orbits have good accuracy characteristics. However, a shortcoming of such systems is that the navigational devices of a ship provide a correction of its position only in the period of presence of the transiting satellite in the zone of radiovisibility. For example, for the American Transit navigational system the mean time between observations at the equator is approximately 1.2 hours [1].

A radical method for eliminating this shortcoming, like many other negative aspects of low- and medium-altitude satellite navigation systems, is the organization of a fundamentally new satellite navigation system, which it is assumed will be achieved with the full activation of systems in accordance with the Timation and Navstar projects.

The Timation system calls for the use of three groups of satellites -- each with 7 satellites (according to some sources -- 9 each), displaced 120° in longitude, with an orbital altitude of 14,000 km and an inclination of about 55°. The organization of the system in the Timation project [2] makes it possible to ensure a constant visibility of not less than two satellites in any region of the earth.

The Navstar system [1, 2] is a new variant of a promising satellite navigation system. With full deployment of the system, which is already planned by 1984, plans call for the use of 24 artificial earth satellites placed in medium-altitude orbits in three inclined planes with eight satellites in each plane with an inclination of 63° and a displacement of 120° in longitude, which ensures simultaneous visibility of four artificial earth satellites at any time at any point on the earth. However, a shortcoming of the Navstar system is evident. This is the great number of satellites used, the unwieldiness of the system and its costliness.

On 1 February 1982 the International Marine Satellite Communications Organization INMARSAT proceeded to the commercial operation of a system which for the purpose of global coverage of regions of the world ocean was based on the use of geostationary satellites.

The working zone of coverage of the world ocean by the INMARSAT satellites with a working angle of the shipboard satellite station of 5° is 75°N-75°S, that is, it covers virtually all regions of world navigation, except for part of the northern regions of the country and the coast of Canada [5].

The INTELSAT Satellite Communications Organization has directed its program for the 1980's to the organization of a communications system in which communication directly between geostationary satellites will be used for ensuring flexibility of the network and reducing the influence of time lag during the propagation of signals [4].

The material presented above indicates the desirability of organizing a navigation system consisting of satellites situated in a geostationary orbit and transmitting data on their coordinates at a real time scale. The principal shortcoming of the system is the need for using on the satellites rather powerful transmitters because they are situated at a great distance from the earth.

Indisputable advantages of stationary satellites include a constancy of their coordinates and simplicity of observation, which is of more than a little importance for the terrestrial observer, and also the obtaining of a high effect from the use of the unquestionably promising passive range finder method for determining the position of an object on the earth's surface.

Systems based on this method are marked by the indisputable advantage that the navigation data are determined on the moving object by a comparison of the signals received from a satellite and the signals of on-board generators. An advantage of such systems is the absence of transmitters on the moving object and also low requirements on the traffic-carrying capacity of the communication channels, not restricting the number of subscribers located in the zone of direct visibility of the satellite. A shortcoming of such systems is the need for using highly stable reference signal generators with a relative instability of a high order. There are a number of solutions for this [1-3] and it can be overcome successfully. For example, the development of cesium frequency standards is known [2]; these meet high requirements with respect to instability. It is possible to use a hydrogen maser with a stability of 1 nsec in 12 days.

However, in the use of geostationary satellites it is impossible to overlook quartz frequency generators installed specifically on high-orbit satellites where the density of protons is negligible and with corresponding screening of the generator it is possible to protect it quite reliably against the dense flux of electrons, thereby achieving a negligibly small influence of radiation on generator frequency and on the rate of its deviation from a clock on the surface [6].

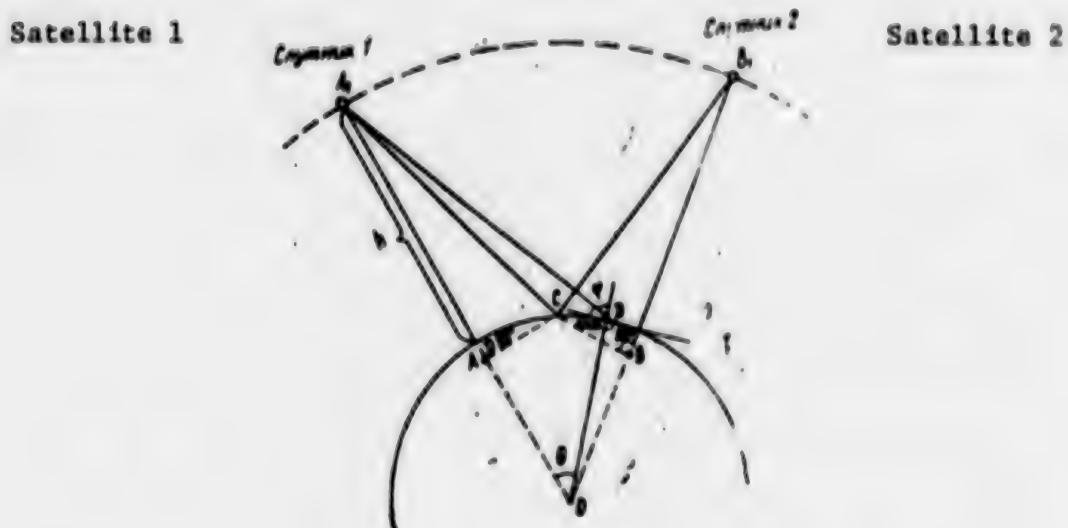


Fig. 1.

In solving navigational problems for obtaining a ship's position the ship requires information as a minimum from two satellites located in the zone of direct visibility. And since in the general mass of information transmitted from the satellite there is information on the coordinates of the points of its hovering, knowing the orbital altitude  $h$  of the satellites (Fig. 1) and also the coordinates of the points A and B below them, it is easy to find C — the ship's position.

The organization of a space navigation system based on the use of geostationary satellites is complex because they do not hover strictly over one point on the earth but move relative to some region. In constructing such systems it is very important to take into account the altitude of satellite hovering (Fig. 1):

$$h = \sqrt{\left(\frac{T}{2\pi}\right)^2 \cdot K} - R, \quad (1)$$

where  $R$  is the earth's radius in the equatorial part (6378.245 km),  $T$  is the period of the earth's rotation about its axis (86400 sec),  $K = k^2 \cdot m$ ,  $k^2 = 6.67 \cdot 10^{-11} \text{ m}^3 \text{ kg} \cdot \text{sec}^2$  is the gravitational constant,  $m = 5.476 \cdot 10^{24} \text{ kg}$  is the

earth's mass, and accordingly

$$K = 5.986 \cdot 10^{14} \text{ m}^3/\text{sec}^2.$$

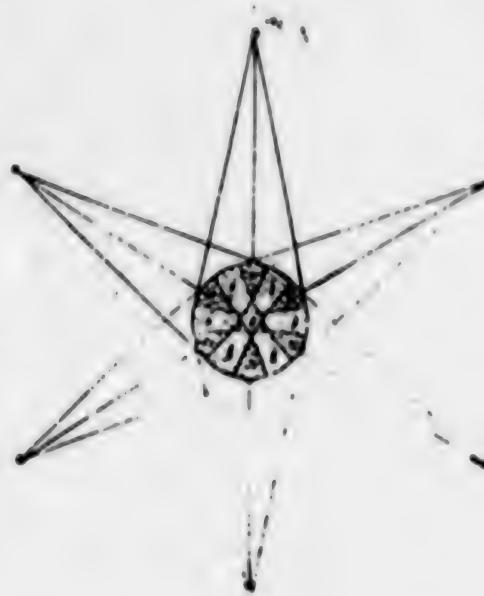


Fig. 2. 0 -- region bounded by latitude  $81^\circ$ ; I -- zone of visibility of one satellite; II -- zone of visibility of two satellites; III -- zone of visibility of three satellites.

Formula (1) shows that for the hovering of a satellite over a specific point on the earth it is necessary that it be launched into a circular orbit with  $h = 35862.762$  km. However, due to the earth's asphericity geostationary satellites for the purpose of maintaining them within admissible limits require the use of special devices for correction of the orbital parameters.

Proceeding on the basis of the condition of the admissible limit of the zone of direct visibility of a satellite from a ship (Fig. 1) with  $\Delta_{\min} = 0$  we have

$$\theta = \arccos \frac{R}{R+h} = 81.315^\circ. \quad (2)$$

that is, from a satellite in a polar plane it is possible to observe a region between  $81.315^\circ\text{N}$  and  $81.315^\circ\text{S}$ .

In order to determine the number of geostationary satellites whose effective zone covers the world ocean we find  $AD = \theta R = 9052.133$  km (Fig. 1) and the system must have

$$n > \frac{\pi \cdot R}{A \cdot D} = 2.21, \quad (3)$$

that is, consist of not less than three satellites. However, for the reliable reception of signals the satellites must hover at an altitude of not less than  $10^{\circ}$  above the horizon and for determining the ship's position it is necessary that two of them be observed simultaneously. As indicated in [3], it is possible to ensure this requirement by launching five satellites into an equatorial orbit, but with such a system definite areas of the world ocean will be serviced by only a single satellite so that this construction cannot solve the globality problem.

The optimum variant of organization of a system of geostationary navigation satellites may be realized in the form of the scheme represented in Fig. 2. Without question a positive factor in such a construction is the presence of zones serviced by three satellites, which is important in the search for methods for decreasing the error in measuring the ship's position; specifically, in this case there is a considerable reduction of the zones.

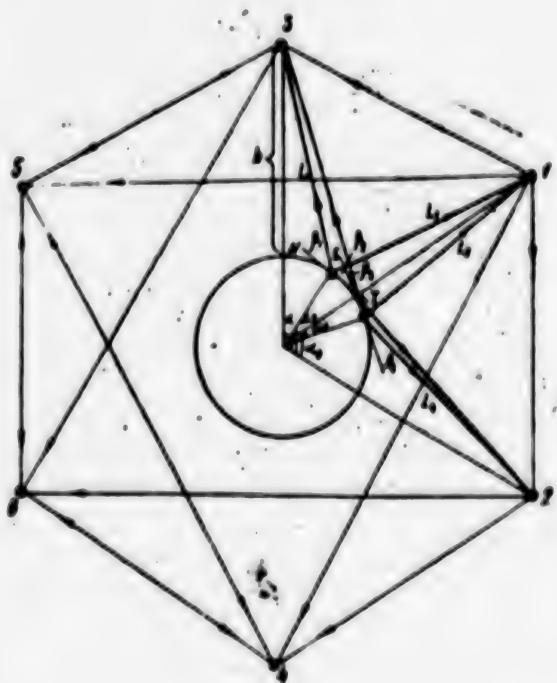


Fig. 3.

In the normal functioning of the system it is completely adequate to have two surface observation stations (Fig. 3) situated in the territory of the USSR and determining the navigational parameters of three satellites situated in the zone of direct visibility. The parameters of the other three, hovering over the western hemisphere, with an adequate degree of reliability can be determined by a range-finding system which is technically easy to realize using laser range finders whose measurement error in open space is considerably lower than on the earth-space path.

As an illustrative example of one of the possible variants of system organization we cite a scheme in which one surface station is located at the point B (b)° E; 42°N), whereas the other is at the point T (70°E...42°N). The coordinates of the points of hovering of satellites 1, 2, 3 (Fig. 3) is accomplished from these stations by the passive rangefinding method. The true coordinates of satellites 4, 5, 6 are determined by laser rangefinders carried on the satellites 1, 2, 3, also by the passive rangefinding method.

The slant range from the observation stations to geostationary satellites is found in the following way:

$$L = [h + R]^2 + R^2 - 2R(h + R) \cos \alpha]^{1/2}. \quad (4)$$

The range for different lines is: point B-satellite 1 -- 36717.894 km; point B-satellite 3 -- 39152.199 km; point T-satellite 1 -- 37048.157 km, point T-satellite 2 -- 39152.199 km. The maximum possible distance between satellites (for example, 1-3) is 73198.214 km.

According to the expression

$$\cos \beta = \frac{(h + R) \sin \alpha}{L}, \quad (5)$$

obtained from the data in Fig. 3 and by use of the sines theorem, the angles of elevation of the satellites above the horizon are  $\beta_1 = 34.22^\circ$ ,  $\beta_2 = 78.48^\circ$ ,  $\beta_3 = 67.04$ ,  $\beta_4 = 34.22^\circ$ .

In order to ensure reliability of this principle in organizing the system it is necessary and adequate that each satellite (other than satellite 1) carry two laser rangefinders. In Fig. 3 this is represented symbolically by arrows emanating from each satellite. Satellite 1 must carry four rangefinders. Such a solution of the problem of "reserving" the technical means for supplying navigational data on satellites from the 2d to 6th, monitoring of which is accomplished from a minimum of four points (the arrows running to each satellite) will unquestionably increase the index of reliability of the system as a whole and guarantee its functioning even if some one of the satellites malfunctions. The only exception is the first satellite (which is monitored from three points), whose functioning is of primary importance when the system is put into operation and whose navigational parameters are reliably corrected from two surface observation stations. The use of the described system of communication channels solely for the transmission of navigation information can be based on use of a "pseudonoise" signal.

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CSO: 1866/82

## SATELLITE DATA AIDS SHIP NAVIGATION IN ANTARCTIC

Moscow KOMSOMOLSKAYA PRAVDA in Russian 6 Aug 85 p 1

[Article by V. Yunisov]

[Abstract] The article reports on the progress of the sea-and-air operation for leading the scientific expedition ship "Mikhail Somov" out of heavy ice in the Antarctic.

Boris Pavlovich Khimich, head of the Arctic and Antarctic Marine Administration of the USSR State Committee on Hydrometeorology and Monitoring of the Natural Environment, showed the author of the article pictures taken from space satellites, as well as the most recent radiograms that had been received from the "Mikhail Somov" and the icebreaker "Vladivostok" that was escorting it. One picture, which had been obtained with the aid of satellite radar, indicated the locations of iceberg clusters along the route of the ships. On the basis of satellite information received in Moscow and Leningrad, personnel of the marine administration were preparing navigational recommendations and transmitting them to a scientific operations group of board the icebreaker. A radiogram from the "Vladivostok" is quoted in which mention is made of data received from the satellite "Cosmos-1500".

FTD/SNAP  
CSO: 1866/116

SPACE APPLICATIONS

'EKRAN' TV SATELLITE RELAYS DATA FROM WEATHER SATELLITES

Moscow IZVESTIYA in Russian 3 Jul 85 p 6

[Article by V. Shcherban]

[Excerpt] An experiment which is of great interest to seamen and polar explorers of many countries is continuing for the second week in the Arctic. It involves a new method of using the television system "Ekran".

V. Mikhaylichenko, chief state inspector of the Northern Sea Route Administration of the Ministry of the Merchant Fleet, had this to say: "Late last year, scientists of the Murmansk affiliate of the Central Scientific Research Institute of the Merchant Fleet proposed an original method of sending information on the sea ice situation to the technical council of the Northern Sea Route Administration. The information is received in Moscow from a satellite, and from there it is transmitted directly to an icebreaker with the aid of the 'Ekran' system. It was decided to use meteorological satellites of the 'Meteor' system and also of the 'Cosmos' series, which carry so-called 'side-looking radars.' Without going into details, I'll say that such devices are able to 'see' through clouds, fog and even in the darkness of the polar night. The Ministry of the Merchant Fleet received a lot of help in implementing this idea from the State Committee on Hydrometeorology and Monitoring of the Natural Environment, and the USSR Ministry of Communications. Yu. Sinyurin, head of the Hydrometeorological Bureau, does a nice job of processing the information and preparing pictures to be sent."

A. Kapustin, head of a sector of the Murmansk affiliate of the Central Scientific Research Institute of the Merchant Fleet, went on to relate: "Data from satellites are now transmitted to main information-receiving points. There the information is processed and routinely transmitted to ships via television channels. It is interesting to note that ordinary TV sets are used to receive the pictures on ships. Pictures can be recorded on video tape recorders. To learn about the ice situation on ships that have the necessary 'Ekran' equipment, all that it takes is to turn on the TV set at the right time, and the screen will show a picture that is a photograph of the area in which the

ship is located. The photograph from space provides a general picture of the ice situation. Knowing it, we can direct our ice reconnaissance teams to areas where more detailed information is needed. The 'Ekran' TV system also can be used for sending navigational and weather information."

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CSO: 1866/116

SPACE APPLICATIONS

'DISK' COMPLEX FOR INTERPRETATION OF SATELLITE DATA

Moscow IZVESTIYA in Russian 10 Jun 85 p 1

[Article by B. Reznik, correspondent]

[Text] Khabarovsk. Specialists from the German Democratic Republic have installed a hardware complex called "Disk".

"The 'Disk' is a joint development of partner countries of the Council for Mutual Economic Assistance," related Helmut Wolbing, the project's technical director. "The concept of the complex, its software and its principal microcircuits belong to our Soviet friends. A number of its components were made in the People's Republic of Bulgaria."

The "Disk" will help in rapid interpretation of satellite information, on the basis of which accurate forecasts of weather and various natural phenomena on the territory of the Far East can be made.

PTD/SNAP  
CSO: 1866/116

SPACE APPLICATIONS

'SKIF' COMPUTERIZED SPECTROMETER FOR ONBOARD USE

Kishinev SOVETSKAYA MOLDAVIYA in Russian 31 May 85 p 1

[Text] Minsk. A spectrometer called "Skif" is equipped with its own computer and terminal. It was developed by physicists of Belorussia and specialists of the Cosmonaut Training Center imeni Gagarin. This apparatus, which resembles a motionpicture camera, enables space researchers to check photographed material on board an orbiting station, which greatly increases the value of experiments conducted in the interests of forestry, agriculture and geology and in the study of the world's oceans. Such studies yield great returns and are now making it possible to recoup a portion of the money spent on space exploration.

FDT/SNAP  
CSO: 1866/116

SPACE APPLICATIONS

SPACE APPLICATIONS IN GEOLOGY

Moscow LENINSKOYE ZNAMYA in Russian No 31, 7 Apr 85 pp 2-3

[Interview by N. Lesnaya]

[Abstract] On the occasion of Geologists' Day, the article records a conversation with four specialists regarding directions, methods and prospects of spacecraft-aided studies of the Earth in support of geology and mineral prospecting. The four are: Nikolay Vasil'yevich Mezhelovskiy, head of the USSR Ministry of Geology's Administration for Regional Geology and Prospecting-and-Surveying Work; Vladimir Viktorovich Kozlov, chief geologist of the "Aerogeologiya" association; Yevgeniy Gavrilovich Farrakhov, head of an aerospace geological expedition of this association; and Valentin Vital'yevich Lebedev, USSR Pilot-Cosmonaut.

Mezhelovskiy reports that magnetic, gamma-spectrometry, radar, infrared, multizonal and other types of photography and surveying are now being done from aircraft. The branch of science known as space geology has come into being in the last 10-15 years. Mezhelovskiy remarks that not all of the problems in this field have been solved as yet. The physical essence of space-photograph anomalies and their connection with real objects on the ground have not been fully ascertained, in particular.

Kozlov, who heads a group in charge of training cosmonauts to perform geological studies on board orbiting stations, relates that in recent years all station crews have been trained in techniques of visual observation and photography from space. Training flights which cosmonauts have made with specialists over the southern USSR on TU-134 and IL-76 airplanes have been particularly effective, according to Kozlov. Farrakhov mentions some of the advantages of space methods for prospecting mineral resources, and he describes procedures which his group is using to interpret and verify materials obtained by remote methods of study. These methods include space and aerial photography on various scales and in all regions of the spectrum, infrared photography, radar scanning, and photography with varying degrees of sunlight. These materials are interpreted with the aid of a computer whose data bank contains information on all work done previously.

Lebedev shares recollections of geological observations he made from space during a long orbital mission. He received instructions directly from Kozlov as the mission was in progress. Mentioning some of the difficulties he encountered, Lebedev recalls that observations and photography of the area along the Baykal-Amur Railroad had to be performed repeatedly, because the view of this area's structural pattern was affected by cloud cover and by differences in the intensity of sunlight. Despite the high level of training that such observations require, Lebedev expects space geology to receive more emphasis and to undertake more difficult tasks. He foresees the participation of geology specialists in space missions in the near future.

PTD/SNAP  
CSO: 1866/116

SPACE APPLICATIONS

AZERBAIJAN ASSOCIATION FOR RESOURCE STUDIES FROM SPACE

Moscow PRAVDA in Russian 17 Jul 85 p 6

[Article by A. Pokrovskiy, correspondent]

[Abstract] The article reports on the history and activities of the Azerbaijan Academy of Sciences' Research and Production Association of Space Research. It is recalled that the association has grown out of the specialized scientific center called "Kaspiy" (Caspian Sea) that was created in the Azerbaijan academy in 1975 to work on applications of space technology to Earth-resources studies. It was helped along by the USSR Academy of Sciences' Institute of Space Research. Three years later, the "Kaspiy" center became the Institute of Space Research of Natural Resources. Before long, several design bureaus and an experimental plant of space instrument building were assigned to it. The young institution began formulating concepts for the construction of systems for remote studies of the Earth, and developing the scientific and technological principles for the creation of subsatellite complexes for such studies. It soon developed the country's first automated system for aerospace studies of geographical survey areas. Its personnel have worked closely with such organizations as the school of physics of Moscow State University, the Moscow engineering-physics and aviation institutes, the USSR Academy of Sciences' Institute of Radio Engineering and Electronics, and the Leningrad Physical-Technical Institute.

Two years ago, the institute and the facilities affiliated with it were organized into the Research and Production Association of Space Research, the first such association in the Azerbaijan academy. Its general director is Doctor of Technical Sciences T. Ismailov, and its deputy general director for scientific work is Doctor of Physical-Mathematical Sciences A. Mekhtiyev. Also mentioned are Doctor of Physical-Mathematical Sciences A. Abdullayev, deputy director of the Institute of Space Research of Natural Resources, and Rafael Tagiyev, head of the laboratory of aerospace experiments.

FTD/SNAP  
CSO: 1866/116

SPACE APPLICATIONS

USE OF SPACE DATA IN KALMYK ASSR RESOURCE PLANNING

Moscow EKONOMICHESKAYA GAZETA in Russian No 27, Jul 85 p 17

[Article by V. Yezhkov, Candidate of Physical-Mathematical Sciences; Yu. Kiyenko, general director of the State Center "Priroda"; A. Metalnikov, head of a department of the State Committee for Science and Technology; I. Elvartynov, secretary of the Kalmyk Oblast Committee of the Communist Party]

[Abstract] The article reports on the experience of using photographs and other information materials from spacecraft in planning the utilization of natural resources of the Kalmyk Autonomous Republic. Mapping and comprehensive analysis of natural resources of the republic's territory on the basis of space information has been in progress since 1978. The methodology for this activity was developed by the state scientific research and production center "Priroda" (Nature) of the USSR Council of Ministers' Main Administration of Geodesy and Cartography. The activity has supported solutions of problems involving such resources as land and soils, particularly the problem of soil erosion, and pasturage, vegetation, and potential oil and gas deposits.

The article describes the main findings of the resource studies using information from space, and relates how they are being applied to improving the utilization of natural resources. It is mentioned that the USSR State Committee for Science and Technology has appraised this work positively and noted that the experience is applicable to a variety of physical-geographic regions.

In conclusion, the authors of the article mention that organizations which use space information are experiencing a growing need for highly effective equipment for processing and interpreting data of information materials from space, and that the training of specialists who know how to use space information is becoming an urgent task.

FTD/SNAP  
CSO: 1866/116

SPACE APPLICATIONS

UDC 551.501.74:551.593.1

PRESSURE FIELD RETRIEVAL BY REMOTE REFRACTOMETRY FROM SPACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 21, No 1, Jan 85 (manuscript received 5 Jul 83, after revision 27 Oct 83) pp 12-21

GURVICH, A.S. and SOKOLOVSKIY, S.V., Atmospheric Physics Institute, USSR Academy of Sciences

[Abstract] A theoretical study was made of the accuracy in retrieving the vertical profiles of the refractive index and atmospheric pressure by the remote refractometry method with the horizontal nonuniformity of the earth's atmosphere taken into account. RSR (remote sensing by refractivity) is a combination of methods for remote determination of atmospheric parameters based on measurements of refractional attenuation, refraction angles, phase or group lag when probing the atmosphere with electromagnetic or acoustic waves. The article discusses an experimental scheme involving existence of a source and receiver of electromagnetic radiation beyond the limits of the atmosphere on satellites. It is shown that in this way data can be obtained which make it possible to formulate the inverse problem in such a way that its solution will be stable relative to random errors in measuring the angle of refraction. The problem was solved in a numerical experiment on an electronic computer. An effort was made to determine the influence of averaging along the ray on the results of retrieval of meteorological parameters. In the models studied the source was situated in a geostationary orbit and was therefore at rest relative to the atmosphere whereas the receiver was on a satellite with a lower orbit. It is assumed that the orbital planes coincide. The propagation of radiation is examined in the geometrical optics approximation and the ray trajectory is considered a plane curve. The results show that in remote refractometry in its simplest variant, when each vertical pressure and density profile is retrieved on the assumption of local sphericity, it is possible to ensure a spatial horizontal resolution better than 500 m and an accuracy in determining pressure not less than 0.3%. In addition, the position of atmospheric fronts is determined with an accuracy to 100 km. Figures 4, tables 2; references 9: 8 Russian, 1 Western.  
[81-5303]

UDC 528.711.112:771.355.3

## DETERMINING FLEXURE OF AERIAL CAMERA SMOOTHING GLASS

Moscow GEODEZIYA I KARTOGRAFIYA in Russina No 11, Nov 84 pp 30-33

LAVROV, V.N.

[Abstract] Topographic aerial cameras are now in use in which the film is smoothed by being pressed against a smoothing glass on which a grid of fiducial marks is plotted. A significant pressure must be applied for good smoothing. Tests have shown that a pressure of  $1-1.2 \cdot 10^4$  Pa is adequate for ensuring a minimum gap between the film and the smoothing glass. The pressure required for smoothing the film causes elastic deformations (flexure) of the smoothing glass and connected parts of the aerial camera. Glass flexure must be taken into account during camera calibration in order to ascertain what photograph distortions could be a result of this bending. It is indicated in the literature that the glass flexure can attain  $10-13 \mu\text{m}$ , but this was based on inadequate testing. The possible flexures of the glass were examined for two other cases of pressure distribution: uniform and in the form of a triangular prism. It was found that the degree of flexure is dependent not only on pressure, but also on the conditions for attachment of the plate. In the case of plate attachment along the edge moments of forces arise which if known make it possible to compute the resultant flexure. The degree of flexure changes considerably with a change in the form of the load and attachment conditions. A special device was devised for studying the flexure of the smoothing glass. Its use revealed that inadequate rigidity of the camera body also plays a role in the degree of flexure. The flexure can be determined with an rms error of approximately  $1.5 \mu\text{m}$ . Figures 2, tables 2; references 4:

3 Russian, 1 Western.

[48-5303]

UDC 528.71:551.466

## STEREOPHOTOGRAMMETRIC SURVEY OF WAVE-COVERED WATER SURFACE

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 11, Nov 84 pp 33-35

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[Abstract] A methodology and some devices have been developed for a stereophotogrammetric survey of a wave-covered water surface. This makes it possible to obtain and measure quite precisely a model of the investigated sector of a water body, the form, type and characteristics of the waves. A stereophotogrammetric survey of the wave-covered

surface must be made simultaneously by two cameras. Enterprise No 7, in collaboration with the Moscow Institute of Geodetic, Aerial Mapping and Cartographic Engineers, synchronized two 41/7.5 aerial cameras for this purpose. The methodology was worked out in water bodies in Kalinin Oblast where two test areas were established. Geodetic beacons of a special design were developed and fabricated for placement on the bottom of the water body for ensuring synchronization of the cameras at the time of the survey. The plane coordinates of the beacons were determined by trilateration. The adequate number of measurements ensured an accuracy in determining coordinates up to 1 mm. Elevations were determined by geometric leveling with errors up to 1 mm. Technical details of the experiment are given. A special program (CNC 12) made it possible to take into account the nonperpendicularity of the axes of the stereocomparator, film deformation, distortion of the survey camera objective and the earth's curvature. It was possible to determine the accuracy in measuring the coordinates x, y, absolute and vertical parallaxes of points situated on different wave elements (crest, trough, peak, bottom) and marked geodetic points. It appears that the peaks and crests of waves, regardless of phototone quality, are observed considerably more precisely than the troughs and bottoms of the waves. The spatial coordinates of terrain points and the wave-covered surface are observed with a great accuracy when these procedures are followed.

[48-5303]

UDC 551.465.635:629.78

#### EQUATORIAL WAVES IN OCEAN SURFACE TEMPERATURE FIELD ACCORDING TO DATA FROM SHIPBOARD AND SATELLITE MEASUREMENTS

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 11 Jan 84) pp 3-7

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[Abstract] Continuous registry of ocean surface temperature was carried out during the period January-March 1982 on the 34th cruise of the "Akademik Kurchatov" in the period January-March 1982 on the 34th cruise of the "Akademik Kurchatov" in the Pacific and Atlantic Oceans. The objective was a study of the spatial structure of the OST field. Later OST maps were constructed for the easterly equatorial part of the Pacific Ocean on the basis of satellite measurements. Shipboard data on OST were supplemented by and compared with satellite data. Shipboard OST data were obtained using a thermistor towed at a depth of 0.15-0.20 m at a distance of 6 m from the side in a region undisturbed by the ship's movement. The measurement accuracy was 0.05°C. OST satellite maps were used for the region 140-188°W, 15°N-15°S, constructed

at NOAA using digital data averaged in time (7days) and space (50 x 50 km) obtained using a very high resolution IR radiometer on a NOAA satellite in polar orbit. Data from the towed sensors and satellite measurements were compared; there was a satisfactory correspondence between the two. Direct measurements confirmed the existence of wavelike disturbances of the equatorial front (as was earlier established on the basis of satellite observations). The specific hydrophysical characteristics of the equatorial front were obtained for the northern hemisphere winter. Warm spots 200-300 km in diameter with boundaries having a frontal character were discovered on the boundary between the Northern Trades Current and the Equatorial Countercurrent. The satellite and direct measurement data obtained for the OST field for the eastern equatorial part of the Pacific Ocean were in satisfactory qualitative and quantitative agreement. Figures 4, tables 1; references 7: 2 Russian, 5 Western.  
[28-5303]

UDC 634.4:629.78

#### USE OF REMOTE OPTICAL MEASUREMENTS IN AGRICULTURE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 11 Apr 84) pp 8-24

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[Abstract] In 1983 a number of organizations and institutes began joint work on use of remote measurement data obtained from aircraft and helicopters and ground data in the interests of agriculture. The program includes analysis of the factors influencing spectral reflectivity of soils and vegetation, development of methods for interaction between optical radiation and the soil-vegetation system, use of airborne spectrometric instrumentation for evaluating the chlorophyll content in plant leaves and determining the contamination of vegetation, surface studies of selected standard sectors of agricultural fields, regression analysis of data from surface photometric measurements and the parameters of the phytobiometric state of vegetation, organization of a data bank of spectral standards or keys and analysis of the possibilities of allowance for the distorting influence of the atmosphere. The article examines the fundamental theoretical premises for solution of these problems and some of the work done on solution of these problems. Agricultural test areas were organized in the Central Nonchernozem zone and in Central Asia. These test areas made it possible to study a broad range of agricultural and natural

features diverse in spectral and textural characteristics. Work in these areas in 1983 is described. This yielded remote sensing data, synchronous surface observations, television information, spectro-photometric data and quantitative information characterizing the state of the principal components of agricultural resources. A specific, detailed description of this work is given. The collected data made it possible to form a bank of spectral keys of the studied features, analysis of the distorting influence of the atmosphere and determining of the optimum parameters for the implementation of aerial survey work. Figures 4, tables 1; references: 16 Russian.

UDC 526.77:634+629.78

#### CLASSIFICATION OF TREES BY GROWTH CLASSES ON BASIS OF MULTIZONAL PHOTOGRAPHS

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84 (manuscript received 3 May 84) pp 25-30

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[Abstract] The classification of tree stands has the purpose of evaluating their current status and future potential. The traditional, time-consuming subjective surface methods used for this purpose can be replaced by remote multizonal surveys. This article describes a method for automating such work. The method is illustrated using aerial photographs at 1:30,000 for sectors of pine stands taken in August using an MKP-6 camera, as well as surface land inventory data for the same test areas. The procedures for orientation and referencing of the photographs are described in detail. The use of the surface inventory data (coordinates of trees in test area, trunk diameter at height of 1.3 m (d), crown diameter (D), tree height (h), and height to maximum crown diameter ( $h_{D_{max}}$ )) are also used in the automated procedure. A correlation analysis of the two types of data is given. The information yield from the six spectral zones was studied. Since in ground surveys only the d and h parameters are usually used, it was concluded that three spectral zones would be adequate for obtaining comparable data. These three zones are sufficient for classifying the stand on the basis of degrees of depression. The results are correct for photographs of the scale used and the particular phenological phase of forest vegetation prevailing in August. Tables 4; references: 5 Russian.

[28-5303]

UDC 629.78:626.87

EXPERIENCE IN COMPLEX MAPPING OF NATURAL RESOURCES IN AGRARIAN-INDUSTRIAL REGIONS OF NONCHERNOZEM RSFSR USING SPACE PHOTOMATERIALS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 13 Mar 84) pp 31-40

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[Abstract] The following specialized maps must be prepared in the mapping of the natural resources of the Nonchernozem Zone using space photomaterials: natural conditions, present status of environment and resources, conservation of environment and predictions of possible changes in environment. In this zone the makeup of each series can be varied in dependence on the nature of the natural conditions in a specific region. Each series must be supported by a minimum of key maps whose compilation is obligatory for all regions in the Nonchernozem Zone for the purpose of ensuring rational planning of the use of natural resources and their possible restoration. The article describes one of the first experiments in compiling a set of maps on the basis of space photographs in two regions differing in natural conditions in Smolensk Oblast and Minsk Oblast (in which agricultural-forestry and agrarian-industrial economies predominate). The compilation of such maps is described in detail. In the first stage in the work geomorphological, landscape and hydrogeological maps are prepared, followed by compilation of maps of land use, forestry, swamps and swampy lands. Interpretation of the photographs is checked and refined using field investigations; cartographic, published and archival materials are also used. In the second stage work is done on compilation of land improvement projects and erosion danger. The third stage involves compilation of maps of disruption of the soil-vegetation cover or anthropogenic restructuring of environmental conditions. The last stage involves compilation of environmental conservation maps. These are prepared on a landscape base using the results of an analysis of a map of disruption of the soil-vegetation cover or a map of the anthropogenic restructuring of the environment with allowance for long-range plans for the economic development of the region. Figures 3, tables 1: references: 3 Russian. [28-5303]

UDC 551.244:629.78

POSSIBILITIES OF USE OF AEROSPACE MATERIALS IN PREDICTING OCCURENCE OF PETROLEUM AND GAS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 2 Mar 84) pp 41-50

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[Abstract] Aerospace methods can be used in the detection of petroleum- and gas-bearing structures in the combined analysis of aerospace and geological-geophysical data and aerospace photographs can be interpreted for making a more precise determination of the structure of petroleum and gas basins, in particular, fault tectonics. Both these possibilities are discussed in relation to the poorly studied northern part of Western Siberia, an area where at the present time it is not always possible to make a reliable determination of faults, which are of great importance in predicting hydrocarbons. The use of space photography makes possible a rapid and reliable refinement of information concerning the nature of major structures, which can thereby lessen the costs of seismic survey methods. The article outlines the possibilities afforded by the joint interpretation of space photographs and geophysical materials for predicting petroleum and gas. The study was based on intermediate-scale space photographs obtained from "Meteor" satellites at 1:2,500,000 or smaller; these were compared with geological and geomorphological maps at intermediate scales, published geophysical maps of the USSR and the most recent data on neotectonics and occurrences of petroleum and gas. Space survey data make it possible to carry out a regional prediction of the presence of petroleum and gas, whereas an aerial photographic survey makes a local prediction possible. It is stressed that the intersections of fault zones manifested with different degrees of clarity of space photographs are of great importance. The petroleum deposits in the Persian Basin, for example, are also associated with the intersection of faults. The coincidence of intersecting zones and paleodeltas creates a reliable basis for the prediction of deposits of hydrocarbons in various places. The results of interpretation of aerospace materials should assist in preventing costly seismic prospecting and drilling work. They can also be used successfully as additional materials in the interpretation of geophysical data. Figures 1; references:

19 Russian.

[28-5303]

UDC 654.434+551.4:634.11

PROBLEMS IN STUDY AND EVALUATION OF CONSEQUENCES OF FOREST FIRES USING  
AEROSPACE PHOTOGRAPHS

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 10 Jan 84) pp 51-57

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[Abstract] The problems involved in the evaluation of forest fires on the basis of aerospace photographs are discussed. The experience which has been accumulated over the past decade has made it possible to define the principal problems which must be solved. These include developing principles and methods for studying the post-fire forest restoration process; formulation of principles and methods for the regionalization of taiga areas on the basis of the degree of damage by fires; working out of methods for the routine inventorying of areas of recently burned-over areas and determination of the post-fire state of forested areas; defining of principles and methods for evaluating potential damage to forested areas and their resistance to fires. The best times for collecting needed information were determined. In almost every case the best time for such a survey is in summer, in June-August, during the period between total development of the canopy and prior to its autumn coloring. Solar altitude should be 25° or more and the cloud cover should not be greater than 10%. The periodicity of receipt of photo-information for the compilation of maps of post-fire dynamics, maps of forest damage and maps of resistance to fires should be 10-12 years. A table is given outlining requirements on the type of aerospace information required for evaluating the consequences of fires. This requires the use of black-and-white, spectrozonal and multizonal photographs at scales 1:15,000, 1:100,000 and 1:1,000,000. Tables 3; references: 22 Russian.

[28-5303]

UDC 535.361+57.084.2:535.232.65

COMPUTATION OF REFLECTION OF SOLAR RADIATION FROM VEGETATION COVER BY  
MONTE-CARLO METHOD

Moscow ISSLEDUVANIYA ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 2 Mar 84) pp 58-67

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[Abstract] The Monte-Carlo method is used in calculating the reflection indicatrices (reflectance factors) of direct solar radiation from a model field and for explaining the degree of dependence of the form of the indicatrix on such architectural parameters of the vegetation cover as the size of the leaves and the regularity of their distribution along the stem, the density and height of the crop. The results of the first part of the study, formulation of the problem and description of the computation method, are given in this article; a subsequent article will give the results of numerical experiments and their analysis. In the proposed model and optical properties of the soil, leaves and stems are stipulated by the reflection coefficient, transmission coefficient and absorption coefficient. It is assumed that the soil and phyt-elements are dull and the three coefficients are stipulated separately for the photosynthetically active and near-infrared spectral regions. The problem is roughly formulated as follows. A stipulated number of plants are present in a test sector of a model field. Direct solar radiation (a parallel beam of photons) is incident on the field. On its path the incident photon encounters either a leaf, stem or the soil. As a result of interaction with a leaf a photon can be reflected, transmitted or absorbed and as a result of interaction with a stem and the soil, either reflected or absorbed. The reflected or transmitted photon can either escape from the field into the atmosphere or again collide with the leaf, stem or soil. Using an electronic computer it was necessary to simulate random "wandering" of a sufficiently great number of incident photons in the vegetation-soil system and to ascertain the angular distribution of photons escaping into the atmosphere. In computing the vegetation canopy transmission function the direct simulation method gives satisfactory results because each photon makes a contribution to the evaluated functionals. However, in the case of reflection it is more effective to use the Monte-Carlo method algorithm described in this article. Figures 1; references 15: 10 Russian, 5 Western.

[28-5303]

UDC 535.361.2+57.084.2:535.232.65

## REFLECTION INDICATRICES OF VEGETATION CANOPIES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(maniscript received 11 Mar 84) pp 68-75

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[Abstract] A program was prepared for making *in situ* measurements to ascertain the extent to which the reflection indicatrices (reflectance factors) of different plant canopies differ from one another. Specialists at the Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences, carried out measurements of the angular dependence of reflection of solar radiation from natural vegetation canopies and crops in several parts of the spectrum with high angular resolution. The angular dependence of the spectral brightness of vegetation canopies was determined using a narrow-angle aircraft telespectrophotometer mounted on a KA-26 helicopter. Measurements were made at the reflection maximum of the vegetation cover in the green part of the spectrum at  $\lambda = 0.555$  m, at the absorption maximum of chlorophyll at  $\lambda = 0.675$  m and at the maximum reflection plateau  $\lambda = 0.795$  m. The spectral ranges were discriminated by interference light filters with transmission half-widths of 13, 10 and 15 nm respectively. Measurements of the angular characteristics of reflection of fields and natural vegetation were made from a height of 50 m in a stable illumination regime. The measured brightnesses were scaled to spectral brightness coefficients taking into account the spectral illumination measured with a surface spectrophotometer. The angular characteristics of reflection of features were measured on the solar vertical and in the plane perpendicular to the solar vertical in May-June 1981 in winter rye and in July-August 1982 for other canopies situated in the territory of the Estonian SSR. The following types of vegetation were studied: birch forest, pine forest, cultivated grasses, barley field and winter rye field. The collected data show that different vegetation canopies (coniferous forest, hardwood forest, swamp, grains, cultivated grasses) have substantially different scattering properties. All the described structural effects of the vegetation cover, shading, screening and mirror reflection of radiation are more graphically represented in the red part of the spectrum where single reflection dominates and the transmission of leaves is insignificant. In the near-infrared region the multiple reflection of radiation and the great transmission and reflection of leaves smooth and attenuate all these effects and thereby reduce the information yield of the indicatrices. Figures 3, tables 1; references: 13: 7 Russian, 6 Western.

[28-5303]

UDC 535.361.2+57.084.2:535.232.65

APPROXIMATE ANALYTICAL FORMULAS FOR COMPUTING SPECTRAL BRIGHTNESS COEFFICIENTS FOR AGRICULTURAL VEGETATION

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 11 Mar 84) pp 76-83

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[Abstract] Due to the recent vigorous development of aerospace optical sensing of vegetation a great need has arisen for effective theoretical models of the spectral brightness coefficients of vegetation canopies, especially agricultural vegetation. Existing models are either too unwieldy and inconvenient or too simplified and to the necessary degree do not deal with important aspects of the problem. Accordingly, an effort has been made to fill this gap. The authors propose a model for formation of spectral brightness coefficients of agricultural crops in the form of approximate analytical formulas, which present no difficulties for computation. The formulas have an acceptable accuracy for all the principal regularities exerting an influence on the value of the spectral brightness coefficient. In the model it is assumed that the vegetation consists of randomly (in conformity to Poisson's law) distributed phytoelements with spherical orientation. The phytoelements reflect and transmit radiation in conformity to Lambert's law and it is assumed that the mirror component of radiation reflected directly from the surface waxy layer of the leaves, whose brightness is described by Fresnel's law, can be added to the reflection from the phytoelements. In the described model, despite satisfactory agreement between the computed and measured spectral brightness coefficients, it is nevertheless clear that in this simplified model it is impossible to give a quantitatively correct description of absolutely all the effects associated with the temporal variation and angular dependence of the spectral brightness coefficient of agricultural vegetation. This applies, in particular, to the finer effects associated with the structural peculiarities of fields of agricultural crops. Figures 4; references 7: 6 Russian, 1 Western.

[28-5303]

UDC 681.3:528.72

METHOD FOR USING CLUSTERS IN EVALUATING LAND USE AREAS FROM MULTIZONAL PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 28 Mar 84) pp 94-99

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[Abstract] In the study of agricultural landscapes the problem arises of clustering the results of measurement of multizonal images. In such surveys the spectral brightnesses of vegetation are continuously distributed in some interval and there are no natural cluster. This article describes the method developed and the results obtained in the classification of land use areas with cultivated vegetation on multizonal photographs based on an increase in the criterial space of spectral measurements with data on the spatial (geographical) distribution. Within the limits of a homogeneous landscape adjacent fields are occupied by different crops. The problem is solved under the condition that two adjacent fields occupied by crops belong to different classes and this is used as a proximity test in the formalization of a cluster analysis model. The cluster analysis procedure applicable to this problem is discussed in detail. The clustering method in this case was applied in inventorying agricultural fields from multizonal space and aerial photographs taken with the MKF-6 camera. A statistical sampling with field clustering was used in the "Telefoto-82" experiment executed under the "Intercosmos" program in the Polish People's Republic in the neighborhood of Wroclaw in July 1982. The results of clustering of 213 fields are presented as an illustration. By the procedures described it is possible to classify agricultural crops with a considerable decrease in field data using the properties of their relative positioning in spectral criterial space. The method has demonstrated its effectiveness in solving practical problems in the inventorying of crops. Figures 4, tables 2; references: 3 Russian.

[28-5303]

UDC 528.77+629.786.2

METHODS FOR COMPLEX SPACE EXPERIMENT IN USSR FOR STUDYING LAND FROM  
MANNED SPACECRAFT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 23 Jun 83) pp 100-106

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[Abstract] A combined subsatellite experiment is one of the most important approaches in investigations of natural resources from space. Also called a combined space experiment, it involves use of surface, aerial and space vehicles and instrumentation. The correct implementation of such an experiment requires adherence to a number of rules relating, in particular, to the comparability of data: temporal, spectral and spatial. In the USSR such experiments have become increasingly complex and have proceeded through the following states: 1) study of space survey transfer function (geophysical experiment in 1969--Ustyurt Plateau); study of reliability and detail of recognition of natural features from space photographs (informational experiment in 1970--Salsk steppes); study of effectiveness of special mapping, revision of existing maps and compilation of new types of maps (mapping experiment in 1971--Altay and Balkhash key sectors); study of dynamics of natural and anthropogenic systems by successive surveys for registry and prediction of changes (dynamic experiment in 1978--Salsk key sector); study of rhythmic change in natural systems for registry of short-period changes, their prediction and choice of optimum survey conditions (phenological experiment in 1981--Kyzylkum key sector). The principles for each type of experiment--geophysical, informational, mapping, dynamic and phenological--are outlined.

Figures 5; references: 21 Russian.

[28-5303]

UDC 551.46.0:629.78

EXPERIENCE IN CONDUCTING SUBSATELLITE EXPERIMENTS WITH WATER BODIES IN  
USSR AND HUNGARIAN PEOPLE'S REPUBLIC

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 9 Apr 84) pp 107-111

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[Abstract] International subsatellite experiments were carried out in June 1983 at Lake Balaton in Hungary and in September 1983 in the Sea of Azov-Don River areas. The objectives included testing and perfecting of methods for specialized interpretation of space information developed in joint research by USSR and Hungarian specialist; obtaining synchronous and quasisynchronous shipboard, aerial and satellite data needed in study of radiation-hydrophysical relationships and the formulation of systematic recommendations on remote determination of hydrochemical and hydrobiological indices of water bodies. Perfecting the methods and technological elements for speedy collection and primary processing of control information in test ranges. At Lake Balaton there was a test of the so-called "direct" algorithm for the interpretation of multizonal videoinformation. Spectral brightnesses in different channels were compared with the values of hydrochemical, hydrobiological and hydrooptical parameters measured synchronously in a space survey. Two test sectors with different degrees of trophicity were selected for this purpose. Control information was selected synchronously with the space survey from aboard a research ship and two small boats. The hydrochemical, hydrobiological and hydrooptical characteristics were compared with the intensities of the spectral brightnesses of the corresponding sectors. These data were used in mapping the content of phytoplankton in Lake Balaton in four gradations. In the Sea of Azov-Don River areas both "direct" and "indirect" algorithms were employed. A research ship, two aircraft laboratories and a helicopter were employed. The two test sectors selected differed considerably from one another with respect to trophicity and the concentration of suspended mineral matter. Measurements of the spectral brightness coefficient were made in the wavelength range from 440 to 780 nm, as well as the extinction index of water in situ at eight wavelengths in the range 440-760 nm, the concentration of chlorophyll A, mineral suspended matter, numbers and biomass of phytoplankton, temperature and specific conductivity of water. In this case as well the collected data confirmed the legitimacy of the interpretation algorithms employed. References: 6 Russian.

[28-5303]

UDC 528.946:631.4:629.78

POSSIBILITIES OF USING SPACE SURVEY FOR STUDYING SEASONAL CHANGES OF LANDSCAPES IN SOME REGIONS OF USSR

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 27 Jan 84) pp 112-114

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[Abstract] The northern regions of the European USSR, almost all of Siberia and the Far East are phenologically very poorly studied. However, the need for such phenological data is felt most strongly in these vigorously developing parts of the country. It is virtually impossible to obtain necessary information rapidly in these regions by traditional surface methods. This dictates the use of aviation and artificial earth satellites with the application of already developed remote phenology methods. The article examines the realistic possibilities for collection of such information in a space survey. It was found that in the wooded steppe and taiga regions of Siberia the greatest number of days with a cloudless sky is in January-March. However, space photographs taken at that time contain the minimum phenological information. In comparison with the winter months, a cloudless sky is very rare in spring, summer and autumn. The sky is usually partially or completely covered by clouds. In the months most suitable for remote phenology (May-August) only 10% of the days are reasonably clear. In the more southerly, dry regions, such as Central Asia, there are considerably more days with few clouds. In winter (November-February) the number of clear days varies in the range 20-35%; in summer (June-September) it is 50-70%. Accordingly, a phenological survey from space in these regions would have a high probability of success due to the great number of clear days. However, in the mountainous sectors of these regions unfavorable conditions prevail, much like in the taiga. Figures 2; references 9: 8 Russian, 1 Western.

[28-5303]

UDC 528.946:629.78

ROLE OF LANDSCAPE RESEARCH IN DEVELOPMENT OF SPACE METHODS FOR STUDYING EARTH

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 84  
(manuscript received 25 Nov 83, after revision 21 Jun 84) pp 115-121

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[Abstract] This is an overview of the contributions which space surveys are making to the development of the earth sciences, with emphasis on landscape (geographical-environmental) research. Space methods are sweeping traditional methods away or are reducing them to a secondary role. Attention is given to 23 branches of the earth sciences with 82 key problems considered which can be investigated by remote sensing methods. The advantages of remote sensing in study of the atmosphere, hydrosphere, biosphere, sociosphere and in landscape geography are discussed. A table gives a detailed listing of the scientific, practical and economic problems which can be solved in space methods. References are made to the monographs, brochures, transactions, collections of articles and individual articles which give the best information concerning different aspects of these problems. Space methods have already served as a basis for a number of fundamental landscape investigations at a regional level. The landscape research method is now also being used in study of the geographical zonality of the world ocean. Figures 1, tables 1; references 31: 30 Russian, 1 Western.  
[28-5303]

UDC 528.72(202):535.36

METHODS FOR CONSTRUCTING ATMOSPHERIC OPTICAL TRANSFER OPERATOR

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 10 Nov 83) pp 14-22

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[Abstract] The functional scheme for digital processing of space videodata contains a block for eliminating atmospheric radiation distortions. The modeling of this block involves use of an atmospheric optical transfer operator transforming the albedo of the earth's surface into the brightness of the registered radiation. There are two methods for constructing the mentioned operator. These are the multiple rereflections method (Yu. G. Spiridonov, TR. GOSNITsIPR, No 10, pp 98-106, 1980) and the spatial frequency characteristics method

(I.V. Mishin, ISSLED, ZEMLI IZ KOSMOSA, No 4, pp 95-104, 1982). The basis for these methods is solution of the radiation transfer equation in the layer of a scattering medium over a surface with a nonuniform albedo. This article gives a comparison of these methods. The analysis reveals that these methods, differing with respect to the procedures for summing the registered photons, yield identical results. The multiple rereflections method, characterized by simplicity and compactness, makes it possible to write a precise solution for the inverse problem. In this method it is easy to make computations by the Monte Carlo method, but when using other computation methods the radiation transfer theory requires a more detailed representation. The spatial frequency characteristics method involves more unwieldy computations, involving discrimination of the mean and variable components of the albedo function for the earth's surface. On the other hand, a positive point is that in the course of the computations use is made of a precise solution of the boundary value problem relative to radiation brightness with a mean surface albedo, taking into account all photons rereflected by the surface. Some results of numerical computations are given, in particular, for the amplitude-frequency characteristics of an atmospheric layer with a real indicatrix and a vertical stratification of optical thicknesses.

Figures 2; references: 8 Russian.  
[186-5303]

UDC 502.3:537.531:535.3

#### APPLICATION OF STATISTICAL MODEL OF LAYERED MEDIUM FOR COMPUTING THERMAL EMISSION OF ICE COVERS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 3 Jan 84) pp 33-38

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[Abstract] In computing the thermal emission of a medium with the temperature  $T = \text{const}$  it is customary to use a formula based on the reciprocity theorem in which the brightness temperature  $T_{br}$  is expressed through the coefficient of reflection (or absorption) of a plane wave incident on the particular medium:  $T_{br} = T(1 - |R|^2)$  or  $T_{br} = TQ$ . Here  $|R|^2$  and  $Q$  are the energy coefficients for reflection and absorption respectively. Such a theoretical approach, in the case of sufficiently smooth temperature changes, is also applicable to nonuniformly heated bodies. The author examines a one-dimensional randomly inhomogeneous medium occupying the half-space  $-\infty < z \leq 0$ . It is assumed that its dielectric constant is not dependent on temperature. It is shown that there are few difficulties in making analytical computations of the thermal emission of a semi-infinite layer whose dielectric constant changes randomly

for interpretation of data from remote sensing of ice covers. The most suitable natural media to which the results can be applied are extensive ice formations such as the Antarctic continental glacier which have a layered structure and a relatively smooth surface. The model of a layered randomly inhomogeneous medium formulated here has already been used in computations of the thermal emission of ice. L. Tsang and J. Kong (RADIO SCI., Vol 10, No 12, pp 1025-1033, 1975) used this model and radiation transfer equations in making computations of the brightness temperature of Antarctic ice. Figures 1; references 7: 6 Russian, 1 Western.  
[186-5303]

UDC 911.2:581.9(528.77+629.78)

COMPIRATION OF LANDSCAPE MAPS AT DIFFERENT SCALES WITH USE OF SPACE PHOTONFORMATION

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 13 Mar 84) pp 39-45

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[Abstract] A methodology is being developed for the detailed mapping of natural resources and conditions on the basis of a series of special-purpose maps with the use of space photoinformation. In such work a fundamental role is played by landscape maps which can serve as base maps. Their content is used in compiling a number of specialized maps, which include maps of vegetation, soils, ground water, geochemical characteristics and others. This article gives a detailed description of the preparation of a map compilation in all its aspects, including generalization, editing, legends, etc. This is illustrated for a number of types of terrain in the Soviet subarctic: tundra accumulative plains, tundra mountain folded regions and mountains of intermediate elevation. These examples, prepared at different scales, illustrate the enormous amount of information which can be extracted from space photographs of areas which previously were so remote that their mapping was generally sketchy and unreliable. In addition, the use of space surveys reduces the time required for the preparation of landscape maps by a factor of 3 to 5. Figures 3; references: 7 Russian.

[186-5303]

UDC 550.34 (528.77+629.78)

## USE OF SPACE GEOLOGICAL METHODS IN SEISMOTECTONIC RESEARCH

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 1 Mar 84) pp 46-52

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Moscow

[Abstract] The role of geological analysis of space survey materials for the purpose of evaluating seismic risk is discussed. Field work was carried out during 1980-1982 in the Fayzabad prognostic test range in Tajikstan near Ashkhabad. The objective was to use space photographs in detecting active deep tectonic structures. The images used were from the "Meteor" artificial earth satellite (late 1980-early 1981), taken in the spectral ranges 0.5-0.7 and 0.7-1.1  $\mu$ m. The interpreted lineaments were identified with orographic elements and replotted on a topographic base. (Figure 1 shows a comparison of space photo features and geological data.) It was found that the interpreted lineaments correspond to zones of the most recent dislocations and deformations expressed in the present-day relief, in general forming during the Quaternary. Considerable rising of ranges and restructurings marked by lineaments occurred in the second half of the Pleistocene, evidence of recent tectonic activity of faults which is probably still continuing. The space photographs therefore reveal elements of active deep tectonics. Some of these lineaments coincide with zones of deep dislocations reaching the Moho and reflected in geophysical anomalies. Other more recent deformations are intracrustal formations. Lineaments can be defined as zones bounding crustal blocks differing in structure, depth of penetration and nature of most recent tectogenesis. The considered territory can be divided into three lithospheric blocks which differ with respect to present-day kinematic and dynamic parameters. The zones of joining of the blocks are probably characterized by the maximum intensity of geodynamic processes. Figures 2; references: 13 Russian.

[186-5303]

UDC 551.435(574):629.78

ENGINEERING EVALUATION OF CRUSTAL FAULTS USING SPACE SURVEY DATA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 10 Jan 84) pp 53-60

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[Abstract] The materials presented in this article show that the interpretation of space photographs, on the basis of a geomorphological analysis of the images, makes it possible to give an engineering evaluation of faults whose reliability and completeness is considerably greater than the information obtained by engineering field work on the ground for selecting an optimum variant of the layout of linear structures such as railroads, highways, tunnels, canals and pipelines. The preliminary interpretation of space photographs in combination with traditional methods for carrying out geological field work for engineering purposes results in the optimizing of such work and a decrease in work input due to the highly sound distribution of volumes of costly work, an increase in the completeness of pertinent geological and engineering data, a choice of effective planning solutions in contending with fault zones and warning of emergency situations when carrying out construction work. The interpretation of space photographs should occupy a leading place in the implementation of work involving the choice of optimum variants of trajectories of linear structures in tectonically complex regions. All this is illustrated in specific experience gained in such regions as along the Baykal-Amur Railr... and in the Caucasus in the latter case, for example, the completeness and accuracy of interpretation could be considered 100%. On-site geological and engineering work lacked the necessary volume of information on the presence of faults dangerous for construction. Figures 5, tables 1; references: 1 Russian.

[186-5303]

UDC 631.4:629.78

USE OF GOUDRIAAN MODEL FOR STUDYING REFLECTION REGULARITIES IN VEGETATION-SOIL SYSTEM IN OPTICAL RANGE. I. INFLUENCE OF PHYTOMETRIC PARAMETERS ON SPECTRAL BRIGHTNESS COEFFICIENTS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 11 Mar 84) pp 61-70

VYGODSKAYA, N.N. and GORSHKOVA, I.I., Geography Faculty, Moscow State University imeni M.V. Lomonosov

[Abstract] In a study of the reflectivity of the vegetation cover in the optical range it is best to use theoretical models of reflection of the vegetation-soil system based on the theory of radiation transfer in a turbid medium. A table gives the characteristics of some theoretical models of the radiation regime of the vegetation cover, which are discussed. Among these the authors selected the J. Goudriaan theoretical model (CROP MICROMETEOROLOGY: A SIMULATION STUDY, Wageningen, 1977). This model belongs to a class of models based on the theory of radiation transfer in a turbid homogeneous medium. The vegetation cover is simulated by a layer infinite in the horizontal direction with a random spatial distribution of phytoelements conforming to the Poisson law and consisting of  $m$  thin layers of a given thickness. Numerical experiments with this model make it possible to determine the type of dependence between the spectral brightness coefficient and the relative surface of the phytoelements for conditions of sighting to the nadir and a solar altitude greater than  $55^\circ$ . It was possible to obtain computed values of the spectral contrasts between the coefficients of spectral reflection of the soil and individual phytoelements at which the pertinent dependences are decreasing or increasing functions. The influence of the spatial orientation of the phytoelements was evaluated. The practical application of the results requires the availability of catalogues of coefficients of spectral reflection of soils and individual phytoelements of plants prepared for different regions with allowance for possible changes in the states of soils and plants. Figures 3, tables 3; references 27: 14 Russian, 13 Western.

[186-5303]

UDC 631.4:629.78

ANALYSIS OF SURVEY CONDITIONS AND EFFECT OF NOISE ON QUALITY OF SENSING  
OF SOIL FORMATIONS

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 25 Oct 83) pp 71-80

KARASEV, A.B. and PANTYUKHOV, S.V., Moscow Physical Technical Institute

[Abstract] The results of numerical modeling of remote sensing of the soil cover in the visible spectral range are presented as a contribution to development of an improved remote aerospace method for studying soils. The physical model of the problem is outlined. The authors used this model in examining the principal factors exerting an influence on quality of an image obtained by a survey system and characterized by the signal-to-noise (S/N) ratio and contrast. It was found, for example, that many types of soil formations which have experienced degradation, erosion or salinization are characterized by high S/N ratios relative to undergraded sectors. This is a wide range of optimum observation angles for which the S/N ratio and contrast are optimum. The magnitude and range of these angles are slightly dependent on solar zenith angle and change in optical thickness of the atmosphere; the observation angle at which the S/N ratio and contrast reach their maximum is not equal to the angle of the maximum spectral brightness value for the studied formation. Measurements of the coefficients of spectral brightness of natural formations must be accompanied by determinations of solar zenith angle and optical thickness of the atmosphere, as well as the reflection characteristics of the surrounding background. In special cases, such as cultivated fields, the relative azimuth of the characteristic direction of the structure must also be found. In general, the findings of this study can be applied in stipulating observation conditions for detecting different types of soil degradation. Figures 6, tables 1; references 12: 10 Russian, 2 Western.

[186-5303]

UDC 535.214.4

NORMALIZATION OF RESPONSE OF RADIOMETRIC INSTRUMENTATION FOR STUDYING EARTH'S NATURAL RESOURCES

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 24 May 83) pp 81-88

KHOLOPOV, G.K., KHISAMOV, R. Sh. and KHUZIN, F.G.

[Abstract] Various methods are known for normalization of the response of radiometers both on the basis of spectrozonal photometric parameters and on the basis of their spectral density at some mean wavelength. All of these have had shortcomings. This article describes a normalization method which represents a further development of the methodological results published by G.K. Kholopov, et al. in OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST', No 10, pp 6-8, 1977. The practical use of that method revealed that it usually ensures a sufficient accuracy in measuring spectrozonal photometric parameters, such as the energy brightness of natural features illuminated by direct and scattered solar radiation. Various corrections have been introduced into the method in the course of its use. These are discussed. In this further refinement of the method the fundamental change is a replacement of the real characteristic of absolute spectral response of each radiometer spectral zone, which is determined as a result of radiometer calibration and thereafter is considered known, by an idealized characteristic. An algorithm is outlined which takes into account the test of the minimum of the standard deviation of the idealized resultant spectral characteristic of the radiometer-measured source system from the real characteristic. This is illustrated in a practical example. It appears that in the normalization of the response of a multizonal radiometer intended for remote sensing of the earth it is not the continuous spectrum which should be used, but some typical spectrum of the earth's surface with allowance for the absorption lines of atmospheric gases. Figures 2, tables 1; references 11: 8 Russian, 3 Western.

[186-5303]

UDC 528.711.1(202).007

RADIOMETRIC CORRECTION OF MATERIALS OF AEROSPACE SURVEY OF EARTH WITH  
MKF-6 CAMERA: METHODOLOGY AND USE OF RESULTS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 1 Mar 84) pp 89-94

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[Abstract] The transfer characteristics of the entire multizonal system of an aerospace survey (atmosphere - zonal filter - objective - photographic film) have a distinct angular dependence relative to its main optical axis. This can result in a nonuniformity in light distribution over the frame field, the appearance of a central spot on photomaterials whose presence greatly lessens the possibilities for their quantitative digital processing and correct interpretation. This effect has been observed in countless cases, as in the joint USSR-Cuba TROPICO-3 space experiment on multizonal photographs of sugarcane fields, with serious resultant distortions. It was found that the nonuniformity of brightness distribution over the frame is essentially dependent on the number of the MKF-6 camera channel, varying from  $\pm 10$  to  $\pm 25$  from the mean brightness and sometimes is asymmetric relative to the center of the frame. This effect is the result of multiplicative noise attributable to the angular dependence of the parameters of the MKF-6 survey system and the scattering properties of the atmosphere. This can cause additional errors or even make image digital processing virtually impossible. The author has therefore developed a method for compensating this interfering multiplicative noise and for evaluating its residual influence on the results of photointerpretation. Such noise can be compensated by the automatic amplification control method. Precise and approximate correction methods are described. These are illustrated in a specific example showing that the accuracy in classifying cane fields can thereby be substantially improved. Figures 3; references: 5 Russian.

[186-5303]

UDC 528.72(202):621.397.6

SOME APPROACHES TO ORGANIZATION OF DATA BANK IN SYSTEM FOR STUDYING EARTH'S NATURAL RESOURCES FROM SPACE (USING EXAMPLE OF AGRICULTURE)

Moscow ISSLEDUVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 18 Aug 82, after revision 22 Jul 83) pp 103-109

SIMONOV, Yu. G., DEREVYANKO, N.F. and BARVYN', G.I., Geography Faculty, Moscow State University imeni M.V. Lomonosov; All-Union Scientific Research Institute of Technical Organization, Moscow

[Abstract] The authors discuss the problems involved in the logical and physical organization of data in a data bank of space information using the example of solution of problems in the processing of images in the interests of agriculture. Such a data bank oriented on the monitoring of agricultural production must ensure the possibility of accumulation and comparison of different kinds of data corresponding to administrative-economic units. Data must be organized in such a way as to ensure simple access to the information. The needs of two types of users must be satisfied: users seeking information from the bank directly from a terminal for the purpose of obtaining reference or statistical information relating to some administrative-economic units; programmers involved in processing images or working on automated mapping, using information from the data bank as a reference in the interpretation of current aerospace information, in an analysis of the dynamics of observed objects or phenomena and also for the purpose of compiling special maps. Much of the article describes the makeup and logical structure of the information files and discusses the special set of programs which is required for developing, managing and operating the data bank. This is followed by a listing of the fundamental principles of planning data banks (these principles would be applicable to various other types of information, not only agricultural information). References 10: 2 Russian, 8 Western.

[186-5303]

UDC 681.3:528.72

EXPERIMENT FOR EVALUATING ACCURACY IN DETERMINING LAND CATEGORIES ON  
SPACE SCANNER PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 17 Feb 84) pp 110-119

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[Abstract] In small-scale forest mapping on the basis of space scanner information the problem arises of obtaining the quantitative characteristics of the correctness of recognition of categories of lands and sectors of forest with different predominant species. This article gives the results of an automated experiment carried out with a specialized digital complex. The survey materials used were space scanner photographs in the form of records on magnetic tapes. The video information was sent to a display screen in the form of color images synthesized in two or three zones at a scale of 1:85,000. The method for carrying out the automated experiment is described in detail (a method for evaluating accuracy is included). The computer experiment consisted of preparatory and main stages. In the preparatory stage, display frames of video information registered on magnetic tapes are formed and a network of test (control) sectors is prepared. The net is prepared using forest maps and the results of on-the-ground inspections. The main task is the selection of representative sectors of a given area for each class of objects which can be identified on the photography and reliably identified. The selected test sectors are marked on the digital images stored in the system together with their coordinates. In the formation of the display frames a number of operations are involved: choice of necessary zones, refinement of matching of zonal images, filtering of line structure, elimination of "reject" lines, contrasting and color synthesis. (The main stage of the experiment is clarified by a block diagram, which serves as a basis for the detailed explanation of these procedures.) The technical equipment used in the experiment is described and the various programs employed are listed. Two recognition methods, one- and two-step color selection, are described and compared. It was found that the two-step method produces a 2% increase in accuracy in determining land categories and predominant species. The recognition results improve with an increase in the number of control sectors. Other influences are also evaluated. The results of application of the method are illustrated in an example. Figures 5, tables 3; references: 4 Russian.

[136-5303]

UDC 551.46.0:629.78

REMOTE TEMPERATURE DETERMINATION OF TERRESTRIAL COVERS FROM POLARIZATION INVARIANT OF MICROWAVE-RADIO THERMAL EMISSION

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 84  
(manuscript received 14 Oct 83) pp 120-123

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[Abstract] The emission coefficients for a plane surface in vertical ver and horizontal hor polarizations with observation at an angle of 45° are interrelated by the polarization invariant  $T_{cov}^{in} = \frac{1}{2}(T_{hor}^{2/3} - T_{ver}^{2/3}) = 1$ . It has been proposed that this interrelationship be used in determining the thermodynamic temperature of terrestrial covers  $T_{cov}$  from aboard flight vehicles on the basis of the measured radiobrightness temperatures in vertical  $T_{ver}$  and horizontal  $T_{hor}$  polarizations at a sighting angle 45° using the expression  $T_{cov} = T_{hor}^{2/3} / (2T_{hor} - T_{ver})$ . Under real conditions the accuracy in determining temperature of surface features can be influenced by the width of the polar diagram of the receiving antenna, random surface irregularities, radiothermal emission of the atmosphere and possible variations of the sighting angle (pitching angle) during spaceflight. Each of these factors is analyzed in detail. It is shown, for example, that the width of the receiving antenna polar diagram exerts no influence on the accuracy in determining the temperature of surface covers. On the other hand, the presence of random surface irregularities necessitates a correction of the polarization invariant. It is shown that in order to reduce the error in determining  $T_{cov}$  it is best to use the wavelength range in which there is little thermal emission; it is therefore best to use centimeter waves. It was found that the  $T_{cov}$  error is minimum with an angle of about 43°. With this angle the error in determining temperature of pastures, concrete pavements and a lake surface does not exceed 3° K in absolute value. Radiometric measurements in two polarizations make it possible to discriminate the boundary between two types of surface cover with identical emission coefficients at the zenith. Figures 3, tables 1; references: 5 Russian.

[186-5303]

SPACE POLICY AND ADMINISTRATION

COMMENTS ON ANNIVERSARY OF APOLLO-SOYUZ FLIGHT

Moscow KOMSOMOLSKAYA PRAVDA in Russian 14 Jul 85 pp 3, 4

[Article by Ya. Golovanov: "Flight of Hope. The "Soyuz" and "Apollo" Spacecraft Were Launched From the Baykonur and Cape Canaveral Sites 10 Years Ago"]

[Text] Was it really 10 years ago? And perhaps we have a right to exclaim differently today: Was it really a whole 10 years ago?! Life is short, and time is precious.

A half-century before the Apollo-Soyuz test mission (ASTP) K.E. Tsiolkovskiy, possessing the uncommon gift of foresight, which is not always the mark even of geniuses, mentally sent off on an interplanetary flight a Russian, an American, a German, a Frenchman, an Englishman, and an Italian.

He wrote with faith and hope: "Mankind is acquiring a world ocean, presented to it on purpose, as it were, so as to link people in a single whole, in a single family..."

The idea of an international flight was brought about by the very nature of cosmonautics, which regards the earth not as a variegated political globe but, on the whole, as mankind's not so large and very vulnerable home. The space era was ushered in by the launch of our satellite on 4 October 1958. As early as 15 March 1958 the Soviet Union advanced proposals for cooperation in space and on 7 and 18 November of the same year submitted its draft resolutions on the same question to the 13th UN General Assembly Session for discussion.

Those proposals were rejected by the United States because they did not ensure its unquestioned supremacy in the international working organs which were to implement UN decisions. The same thing was repeated in December 1959.

Various forms of broad international cooperation, including bilateral agreements between the United States and the USSR, could not have come about of their own accord in isolation from all other more

general and important international problems, such as, for example, the problem of stopping all aggressive wars or the problem of disarmament. John Kennedy could not think seriously of cooperation in space because he could not find ways to cooperate on earth. On the morning of 21 February 1962 he signed a letter replying to the Soviet Government's congratulations on the successful conclusion of John Glenn's flight. In that letter he voiced the hope that Soviet-American cooperation would yield good fruits, but in the evening of that same day, addressing a press conference, he cast doubt on the possibility of such cooperation. And this happened repeatedly.

The words of many American politicians about cooperation in space became part of the standard range of arguments illustrating their boldness and activeness. In September 1969, for example, Senator William Proxmire proposed including a Soviet cosmonaut in the crew of one of the Apollos which was preparing to fly to the moon in the very near future--which would make it possible to impart an international nature to lunar research and reduce the colossal expenditure. But when the Soviet-American flight under the ASTP program began to be implemented, the same Proxmire criticized that program.

The American astronauts always pursued a far more consistent policy. Patriotism and loyalty to the motherland's ideals did not blind those people, who understood better than others that cooperation in space is absolutely necessary. When this was spoken of after Apollo-16 returned from the moon, its commander, John Young, said that he was prepared to learn Russian in order to surmount the "language barrier" and that he was sure that his crew members, Duke and Mattingly, were also prepared to do so.

"The USSR, the United States, France, and other countries which are already conducting extensive space research must pool their efforts," astronaut Charles Conrad said. "We must fathom the ocean of space and go on, beyond the moon. A single country is incapable of doing this. Although the cost of knowledge acquired is constantly increasing, mankind will always seek to acquire it at any cost. For this, quite naturally, people must join forces..."

In various years Neil Armstrong, Frank Borman, Joseph Kerwin, Michael Collins, Gordon Cooper, Eugene Cernan, David Scott and other astronauts have spoken and written of cooperation between the United States and the USSR.

Joint flights were spoken of both in Zvezdnyy Gorodok and in Houston. In March 1970 THE NEW YORK TIMES upbraided President Nixon for the "limited potential for joint projects with other countries" and maintained that real progress in cosmonautics "can be made only through negotiations with Moscow." Even before that an exchange of letters on space cooperation had begun between M.V. Keldysh, president of the Academy of Sciences, and Doctor T. Paine, director of NASA. On 24 April 1970 Thomas Paine talked in New York with Soviet

academician Anatoliy Arkadyevich Blagonravov on this topic. It was then that the talk turned to a new docking collar and the problem of rescue in space. That talk did not come about by accident: Exactly a week previously the rescue ship "Iwo Jima" had plucked from the Pacific the crew of the "unlucky" Apollo-13, which had failed to land on the moon.

The fact that those two events were connected was confirmed by Doctor Glynn Lunney, technical director of ASTP on the American side, who at that time was in charge of rescuing the Apollo-13 crew.

Many Americans approved of the idea of a joint spaceflight not only for technical but also economic reasons. Britain's FINANCIAL TIMES wrote; "The U.S. aerospace industry has welcomed this joint flight project because it has given work to technical specialists in the astronautics sphere, for whom hard times had begun owing to the cut in NASA's overall budget."

By the time the moon shots ended, only 14,000 of the former 300,000 people who had worked on the Apollo program were left, the program budget had slipped from \$3.5 billion to \$128.7 million. There was no money to keep on the specialist cadres and there was no work to make it possible to use the extensive complex of buildings and equipment. It was necessary to mothball for several years space equipment worth almost \$1 billion.

In the light of all those events the very role of astronaut appeared very odious. Since 1959 NASA had selected a detachment of 73 candidates for spaceflights. By the end of the Apollo program 39 were left. Even counting three missions on the Skylab orbital station, some 30 astronauts were being put out of work. Astronaut James Irwin believed that half of them would leave NASA in the very near future, and he was proved right. Later the detachment was in fact disbanded and people were reassigned to various departments of the Johnson Manned Spacecraft Center.

All that has been said convinces us that the Americans needed ASTP. However, I would not like readers to get the idea that only the Americans were interested in ASTP. That is not so. Our cosmonautics also saw many positive aspects in the joint program. For example, the program of a future rescue in space was no less acute for us. In addition, it was precisely at the beginning of the seventies that the Soviet Union had begun a program to create and operate long-term orbital stations with replaceable crews, which were designed to resolve diverse tasks of a national economic nature in near-earth space. Therefore, any progress in the direction of further improving docking was advantageous to us, be it the creation of a more sophisticated docking collar or the perfecting of the rendezvous and orientation systems or of the methods of transferring from one module to another.

But the chief attraction of possible joint work in space lay not so much in the desire to find answers to technical tasks as in the political and, if you like, general human significance of the intended flight. The flight was becoming the real embodiment of our state's foreign policy course and a concrete example of international scientific and technical cooperation between countries professing different ideological convictions. In short, in the eyes of the whole planet this flight asserted the reality and the historical regularity of the peace program which our party had elaborated and which was being implemented unswervingly.

I had occasion to talk in Moscow and Houston with the leaders of the bilateral program: Konstantin Davydovich Bushuyev, corresponding member of the USSR Academy of Sciences, and Doctor Glynn Lunney. They spoke about ASTP with Lieutenant General of Aviation Vladimir Aleksandrovich Shatalov, director of Soviet cosmonaut training; Doctor George Low, technical director of NASA; and Doctor Christopher Kraft, director of the Johnson Manned Spaceflight Center. They all admitted their doubts about the success of the matter right from the start. Trust--at first, perhaps, this was what was required most of all. I well remember the American astronauts' first visit to Zvezdnyy Gorodok, the curiosity and guardedness in their eyes, and the fixed polite smiles which were still to turn into open and friendly smiles.

And then great work began. In connection with ASTP people most frequently remember the new docking collar, the "equal opportunities" capture which replaced the "pin" and the "cone" which had worked prior to this on Soviet and American space craft. Indeed, the docking collar was totally new, but, paradoxical as it may seem, perhaps this was precisely why it was easier to create it: it was built from scratch. As for everything else, both the Soviet Soyuz and the American Apollo were born out of heated creative debates. Both those craft were the result of thoughts, arguments, proofs, and experiments, a result finally balanced and reconciled within its internal contradictions, and, of course, it was relatively ideal in the eyes of its creators. And then someone demanded that this harmony acquired with difficulty, this compromise sought for so long, be disrupted. The resistance to that incursion was natural, but nonetheless it was necessary to break that resistance and to find a new result, find a single denominator for two different and equally sophisticated technical schools. That work was probably the most difficult thing in ASTP. But it was done!

At the time of the flight under the ASTP program I was working in Houson on an assignment for the editorial office. At the time of the Soyuz-16 training flight in December 1974 I was traveling to Baykonur and the control center near Moscow and I was present at all the last examination training sessions in Zvezdnyy Gorodok.

At the time a well-meaning cartoon by Aleksey Leonov was popular in the USSR and the United States: three Texans in pointed cowboy boots, with lassos in readiness, are seated astride Apollo and peer into the starry distance. They ask: "Where have they gotten to?"

I will remember the moment of docking all my life. The television picture was projected onto a large screen in the Houston Center's auditorium. At first, Soyuz, whose solar cells made it look like a small aircraft, kept station at the very edge of the bright aureole of the earth's atmosphere, and then it began to grow rapidly on the screen. Two of its light beacons, its onboard orientation lights, and two more small lights at the very tips of the "wings" of the solar cells were clearly visible. Soyuz was precisely orientated and remained quite stationary in relation to the planet's curved horizon, as though Aleksey Leonov had drawn it on the black sky. Apollo, whose transfer module was coming into the outboard television camera's field of vision, was approaching very certainly, and it was not at all noticeable that it was "taking aim." On the contrary, the impression was that Apollo was rolling toward Soyuz on invisible rails in the sky. The petals of the docking collars at once engaged each other smoothly, firmly, and almost noiselessly. On the huge luminous maps of the world in the two control centers the two dotted lines of the trajectories merged into one bright dotted line: the 22-ton Soyuz-Apollo space complex was flying above the earth.

Applause erupted in the auditorium. At the same instant it was heard in Moscow, at Baykonur, at Cape Canaveral, and everywhere that people were waiting for that truly historic achievement. But still more tumultuous applause rang out a few hours later, when the hatch of the docking module opened and Aleksey Leonov firmly shook Thomas Stafford's hand. The handshake in orbit, repeated so many times in newspaper headlines, became a reality.

"Oh, hi!"--I heard Stafford's voice. He spoke in Russian.

"Valeriy! How are you?"--he shouted to Kubasov.

"Happy to see you!"--this was Leonov greeting his friends in English.

Everyone in the room applauded. You only had to say that you were from Moscow and people began congratulating you, shaking your hand, and patting you on the shoulder with purely American directness, as though it was not Leonov and Kubasov but yourself working in orbit with Stafford, Brand and Slayton. I smiled in reply to the Americans' friendly smiles and remembered Herzen, who wrote that Russia and America are separated by an ocean of salt water but not by age-old biases and prejudices. The SUN appeared at the time with an article entitled "Where the Cold War Ends." And we were so glad to believe this then: Ends!...

In the space museum of the Manned Spaceflight Center in Houston, which had a particularly mighty whirl of visitors during those days, a saying by the American Robert Goddard--one of the pioneers of rocket technology--had been fixed up above one of the stands. These are his words: "It is hard to say what is impossible, because yesterday's dream becomes a hope today and a reality tomorrow." These words were spoken more than a half-century ago, but they sounded particularly convincing at the time of the joint flight: The impossible had become a reality.

A description of all the transfers from craft to craft and of all the common and autonomous experiments could constitute a separate popular science book. I can only say that the whole package of technical, astrophysical, technological, medical and biological research was carried out in full. The craft landed safely and on schedule: Soyuz in Kazakhstan, and Apollo in the Pacific. The whole world paid tribute to the impeccable work of the crews and all the ground services and noted the tremendous political significance of joint efforts and the common victory.

"I see the chief result of the work done," NASA Technical Director George Low told Soviet journalists at the time, "in the fact that it has opened up the doors to the future for us. I hope that cooperation is only just beginning and that our two great countries will continue to work together in space..."

When, after the conversation, we walked past the white buildings and the green, amazingly "heat-resistant" lawns of the Houston Center, we said that--who knows?--perhaps we really would return here in a few years' time and write new reportages on new joint work among the stars.

We have not returned. A pity. I would like to write a reportage about how the American Shuttle docks with the Soviet Salyut; how a new international crew works on a new peaceful program; how a giant space dock is created in orbit to assemble an international, interplanetary manned craft; how it sets off toward Mars; and how Soviet and American lads leave the first footprints on the red sand of the Martian deserts.

Is all this really less interesting than the stupid, senseless, hopeless "star wars" program which, as it were, clasps the entire globe in tight-fitting chain mail and prevents it from breathing? Can President Reagan's space program bring fame to the United States? Space is capable of presenting us with many delights and great pride in belonging to the lofty rank of Man, but can this program arouse any feelings in people other than feelings of fear and alarm for their children, their home, their motherland, and their planet? In the history of cosmonautics there have been successful and less successful programs. But there have been no criminal programs. Does the United States really want to take the lead here? It has been known for hundreds of years since Archimedes' catapults that any military superiority is ephemeral and

that for every weapon a counterweapon is found. Does this mean an arms race again? A new spiral--this time a space spiral--new expenditure, and new senseless work, when there is so much ~~fun~~ ~~rtant~~, necessary work around, work which could make people richer and happier.

ASTP must not be forgotten. It happened. It proved that such a path is possible. This means it can be repeated. Space is infinite, but there are no other paths in it.

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SPACE POLICY AND ADMINISTRATION

SOVIET-FRENCH COMMISSION DISCUSSES JOINT SPACE PROJECTS

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 1, 28 May-10 Jun 85 p 3

[Text] The 19th session of the permanent Mixed Soviet-French Commission, which was held in Paris, examined results and prospects of cooperation in basic and applied research, technology, economics, industry and agriculture, in line with the Long-Term Program of Intensifying Economic, Industrial and Technical Cooperation for the Period 1980-1990.

In particular, the commission noted with satisfaction that two projects in the field of gamma-astronomy -- "Gamma-1" and "Granat" -- are in the process of being carried out. Spacecraft are to be launched in line with these projects in coming years. The French side also confirmed its participation in the Soviet project called "Phobos", which is planned for the study of Mars and its moon Phobos. This mission is scheduled for 1988.

Question of joint experiments during the mission of the next Soviet biological satellite were discussed.

In space meteorology and aeronomy, joint work is being done on the development and perfecting of scientific apparatus for studies of the lower ionosphere, and the possibility of conducting joint experiments on Soviet meteorological satellites is being examined.

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LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
21 Mar 85	Cosmos-1635 --	1,526 km	1,482 km	116 min	74°
	Cosmos-1642	(8 satellites orbited by single launch vehicle)			
22 Mar 85	Ekran	35,600 km	--	23 hrs 46 min	0.4°
		(TV broadcast satellite; circular, near-stationary orbit)			
25 Mar 85	Cosmos-1643	300 km	190 km	89.1 min	64.8°
3 Apr 85	Cosmos-1644	398 km	217 km	90.4 min	70.4°
16 Apr 85	Cosmos-1645	411 km	223 km	90.5 min	62.8°
19 Apr 85	Cosmos-1646	455 km	432 km	93.3 min	65°
19 Apr 85	Cosmos-1647	348 km	180 km	89.4 min	67.1°
25 Apr 85	Cosmos-1648	265 km	196 km	88.8 min	82.3°
26 Apr 85	Prognoz-10-- Intercosmos	200,000 km	400 km	96 hrs 25 min	65°
		(To study interplanetary and near-earth shock waves caused by interaction of solar wind and earth's magnetosphere; carries apparatus developed in USSR and Czechoslovakia)			
15 May 85	Cosmos-1649	396 km	208 km	90.2 min	72.9°

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
18 May 85	Cosmos-1650, -1651, -1652	19,137 km	--	11 hrs 16 min	64.8° (3 satellites orbited by single launch vehicle; to improve elements of a space navigation system for civil aircraft and the maritime and fishing fleets of the USSR; near circular orbit)
22 May 85	Cosmos-1653	322 km	222 km	89.6 min	82.3° (To continue study of earth's natural resources for branches of the USSR national economy and for international cooperation)
23 May 85	Cosmos-1654	365 km	180 km	89.7 min	64.9°
29 May 85	Molniya-3	40,850 km	465 km	12 hrs 16 min	62.8° (For operation of long-range telephone, telegraph and radio communication systems and Broadcast of USSR Central Television programs to points in the "Orbita" network)
30 May 85	Cosmos-1655	1,019 km	992 km	104.9 min	82.9°
30 May 85	Cosmos-1656	864 km	811 km	101.6 min	71.1°
6 Jun 85	Soyuz T-13	(Commander: Col Vladimir Dzhanibekov, Flt-Eng: Viktor Savinykh; docked with "Salyut-7" on 8 June)			
7 Jun 85	Cosmos-1657	313 km	195 km	89.2 min	82.3° (To continue study of earth's natural resources for branches of USSR national economy and international cooperation)
11 Jun 85	Cosmos-1658	39,342 km	613 km	11 hrs 49 min	62.8°
13 Jun 85	Cosmos-1659	379 km	210 km	90.1 min	72.9°
14 Jun 85	Cosmos-1660	1,538 km	1,499 km	116 min	73.6°
18 Jun 85	Cosmos-1661	40,164 km	613 km	12 hrs 6 min	62.8°
19 Jun 85	Cosmos-1662	521 km	478 km	94.5 min	65.9°
21 Jun 85	Progress-24	(Docked with "Salyut-7"--"Soyuz T-13" on 23 June)			

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
21 Jun 85	Cosmos-1663	298 km (For continued studies of earth's natural resources; data is relayed to "Priroda" State Research and Production Center for processing and use)	227 km	89.4 min	82.3°
26 Jun 85	Cosmos-1664	405 km	207 km	90.3 min	72.9°
3 Jul 85	Cosmos-1665	316 km	208 km	89.4 min	72.9°
9 Jul 85	Cosmos-1666	679 km	646 km	97.8 min	82.5°
10 Jul 85	Cosmos-1667	297 km (Biosatellite to study processes of adaptation to weightlessness and radiation safety for space flights)	222 km	89 min	82.3°
15 Jul 85	Cosmos-1668	297 km	216 km	89.3 min	70.4°
17 Jul 85	Molniya-3	40,850 km (Communication satellite for long-distance telephone and telegraph and transmission of USSR Central Television programs to points in the "Orbita" network)	462 km	12 hrs 16 min	62.8°
19 Jul 85	Cosmos-1669	264 km (Docked with "Salyut-7"--"Soyuz T-13" on 21 July; "similar to the 'Progress' spacecraft; carries equipment for performing scientific studies both in autonomous flight and as part of an orbital complex")	193 km	88.8 min	51.6°

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**16 OCT. 85**

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